

Jason Howard Hafner

Physics & Astronomy, MS-61
Rice University
PO Box 1892
Houston, TX 77251-1892

phone: 713-348-3205
fax: 713-348-4150
email: hafner@rice.edu
www.ruf.rice.edu/~hafner

Education and Professional Positions

Associate Director (2004 – present)
Laboratory for Nanophotonics
Rice University, Houston, TX

Assistant Professor (2001 - present)
Department of Physics & Astronomy
Department of Chemistry (2002 - present)
Rice University, Houston, TX

Postdoctoral Fellow (1998 - 2001)
Department of Chemistry and Chemical Biology
Advisor: Professor Charles M. Lieber
Harvard University, Cambridge, MA

Ph.D. and M.A. in Physics (1993 - 1998)
Department of Physics and Astronomy
Advisor: Professor Richard E. Smalley
Rice University, Houston, TX

B.S. in Physics (1989-1993)
Department of Physics
Trinity University, San Antonio, TX

Honors and Awards

Commendation for Excellence in Technical Communications, Laser Focus World (2006)
Smalley-Curl Innovation Award (2005)
Beckman Young Investigator (2002)
National Institutes of Health Postdoctoral Fellowship, 1999-2001
H. A. Wilson Award for outstanding Ph.D. thesis, 1998
Welch Foundation Predoctoral Fellowship, 1994-1998
Presidential Scholarship (Trinity University), 1989-1991

Affiliations

Biophysical Society
American Physical Society
American Chemical Society
Materials Research Society
Laboratory for Nanophotonics, Rice University
Institute for Biosciences and Bioengineering, Rice University
Center for Biological and Environmental Nanotechnology, Rice University

Invited Presentations

“Synthesis, Optics, and Applications of Plasmon Resonant Gold Nanoparticles”, Physical Chemistry Seminar, Harvard University, Cambridge, MA, October 26, 2006.

“Probing Membrane Electrostatics”, Department of Materials Science and Engineering Seminar, Massachusetts Institute of Technology, Cambridge, MA, October 25, 2006.

“Biosensing with localized surface plasmon resonances in single gold nanostars”, 62nd Southwest Regional Meeting of the American Chemical Society, Houston, TX, October 19, 2006.

“Bioplasmonics with Gold Nanorods and Nanostars”, Late News Presentation, Gordon Research Conference on Plasmonics, Keene, New Hampshire, July 27, 2006.

“Plasmon Resonances in Structurally Complex Gold Nanoparticles”, Condensed Matter and Surface Science Colloquium, Ohio University, Athens OH, May 25, 2006.

“Electrostatic and Recognition interactions in the Atomic Force Microscope”, Chemistry Colloquium, Ohio University, Athens, OH, May 24, 2006.

“Probing Membrane Electrostatics”, Cells and Materials: At the Interface between Mathematics, Biology, and Engineering, Institute for Pure and Applied Mathematics, Los Angeles, CA, March 28, 2006.

“Electrostatic and Recognition interactions in the Atomic Force Microscope”, Bioanalytical Chemistry Seminar, U. Wisconsin, Madison, WI, February 23, 2006.

“Localized Surface Plasmon Resonance Sensing with Gold Nanorods and Nanostars”, Biomedical Engineering Seminar, Texas A&M University, College Station, TX, February 13, 2006.

“Localized Surface Plasmon Resonance Sensing with Gold Nanorods and Nanostars”, HSEMB 2006, Invited Lectures at the Nano-Bio Interface, University of Houston, Houston, TX, February 10, 2006.

“Gold Nanorods and Nanostars for Localized Surface Plasmon Resonance Biosensing”, The Molecular Signature of Cancer - From Bench to Clinic and Back again, St. Anne's College, University of Oxford, Oxford, UK, January 13, 2006.

“Gold Nanorods and Nanostars for Localized Surface Plasmon Resonance Biosensing”, Photonic Nanosystems 2005, San Francisco, CA, November 8, 2005.

“Specific and Nonspecific Interactions in Biological Atomic Force Microscopy”, Beckman Young Investigator Symposium, Irvine, CA, August 27, 2005.

“Gold Nanorod Bioconjugates” 207th Electrochemical Society Meeting, Quebec City, Quebec, Canada, May 15, 2005.

“Biological Applications of Plasmon Resonant Nanoparticles”, University of Utah Physics Colloquium, Salt Lake City, UT, March 10, 2005.

"Imaging at the single molecule scale with carbon nanotubes" Federation of Analytical Chemistry and Spectroscopy Societies Conference, Ft. Lauderdale, FL, Oct. 21, 2003.

"Nanoscale Charge Density Mapping in Biological Systems" Physics Seminar, Trinity University, Oct. 7, 2003.

"Single-wall carbon nanotube synthesis and applications", Nanotechnology Seminar Series, GE Global Research, Piscataway, NY, May 16, 2003.

"Single-wall carbon nanotube synthesis and applications", Physics Colloquium, Sam Houston State University, Huntsville, TX, April 29, 2003.

"Imaging Single Biomolecules with Nanotube Probes" 225th American Chemical Society National Meeting, New Orleans, LA, March 24, 2003.

"Microscopic Measurements of Nanotube Growth and Nucleation Rates," NASA-Rice Workshop on Single-Wall Nanotube Growth Mechanisms, San Antonio, TX, February 28, 2003.

"Three bad ways to make nanotube tips and one good one," Seminar at Digital Instruments, Santa Barbara, CA, October 29, 2002.

"Probing biology with atomic force microscopy" Biochemistry and Cell Biology Seminar, Rice University, Houston, TX, April 1, 2002.

"Carbon Nanotubes: Properties, Synthesis, and Applications," University of Houston Organic Chemistry Seminar, Houston, TX, September 17, 2001.

"Detection and imaging at the single molecule scale with carbon nanotubes," American Physical Society March Meeting, Division of Condensed Matter Physics invited symposium: Emerging Technologies for Biodetection, Seattle, WA, March 13, 2001.

"Nanomechanics of carbon nanotube scanning probe microscopy tips," Center for NanoScience of the Ludwig-Maximilians University of Munich winterschool: Sensing and Manipulating in the Nanoworld, Mauterndorf, Austria, February 18-23, 2001.

"Single-walled carbon nanotubes as probes in atomic force microscopy," University of California at Berkeley Condensed Matter Physics Seminar, Berkeley, CA, November 13, 2000.

"Carbon Nanotube as Atomic Force Microscopy Probes," University of Massachusetts at Lowell Physics Colloquium, Lowell, MA, September 20, 2000.

"Carbon Nanotube Atomic Force Microscopy Probes," Brandeis University Condensed Matter Seminar, Waltham, MA, February 16, 2000.

"Carbon Nanotubes as Scanning Force Microscopy Probe Tips," Trinity University Physics Department Seminar, San Antonio, TX, November 21, 1996.

Other Presentations

"Protein Crystals as Scanned Probes" Cancun 2005: Scanning Probe Microscopy, Sensors, and Nanostructures, Cancun, Mexico June 5, 2005.

"Protein Crystal Tips for Bio-Recognition Atomic Force Microscopy" American Physical Society March Meeting, Los Angeles, CA, March 21, 2005.

"Biological Applications of Plasmon Resonant Nanoparticles", Baylor College of Medicine Directors Initiative in Translational Research, Houston, TX, March 14, 2005.

"Gold Nanorod Bioconjugates" Biophysical Society Annual Meeting, Long Beach, CA, Feb. 18, 2005.

"Scattering Spectra of Single Gold Nanoshells" American Physical Society March Meeting, Montreal, Quebec, Canada, March 24, 2004.

"Fluid Electric Force Microscopy for Nanometer Scale Charge Density Mapping in Biological Systems" Biophysical Society Annual Meeting, Baltimore, MD, Feb. 18, 2004.

"Fluid Electric Force Microscopy for Nanometer Scale Charge Density Mapping in Biological Systems" NanoDays 2003, Houston, TX, Oct. 13, 2003.

"Atomic Force Microscopy and Spectroscopy of Biomembranes" Texas Nano Summit, Houston, TX, July, 2003.

"Nanoscale charge density mapping in biological systems" First annual meeting of SPRING, Austin, TX, August, 27, 2003.

"Probing Biology with the Atomic Force Microscope" NanoVivo Conference, Houston, TX, July 31, 2002.

"Microscopic growth rate measurements in single-walled carbon nanotube synthesis by chemical vapor deposition" American Physical Society March Meeting, Seattle, WA, March 12, 2001.

"Individual single-walled nanotube tips for atomic force microscopy" Materials Research Society Fall Meeting, Boston, MA, November 28, 2000.

"Production of single-wall carbon nanotubes tips for biological atomic force microscopy" Heidelberg 2000: Scanning Probe Microscopy, Cantilever Sensors, and Nanostructures, Seattle, WA, May 28, 2000.

"Carbon nanotube atomic force microscopy tips produced by chemical vapor deposition" NanoSpace 2000, Houston, TX, April 4, 2000.

"Growth of high resolution carbon nanotube scanning probe microscopy tips by chemical vapor deposition" Materials Research Society Fall Meeting, Boston, MA, December 1, 1999.

"Growth of Carbon Nanotube AFM Tips by Chemical Vapor Deposition" Seattle '99: Scanning Probe Microscopy, Cantilever Sensors, and Nanostructures, Seattle, WA, May 30, 1999.

Book Chapters, Reviews, and Popular Articles

7. H. Liao, C. L. Nehl, J. H. Hafner, "Biomedical Applications of Plasmon Resonant Metal Nanoparticles" *Nanomedicine* 1, p201-208.

6. J. H. Hafner, "Plasmonics – Gold Nanoparticles are Shaped for Effect," *Laser Focus World*, April 2006.

5. J. H. Hafner, "Probes in Scanning Microscopies," *Nanotribology and Nanomechanics: An Introduction*, Bhushan, Ed (2005).

4. J. H. Hafner, "Probes in Scanning Microscopies," *Springer Nano Handbook*, Bhushan, Ed (2004).

3. J. H. Hafner, C. L. Cheung, A. T. Woolley, C. M. Lieber, "Structural and functional imaging with carbon nanotube AFM probes," *Progress in Biophysics and Molecular Biology* 77, 73-110 (2001).

2. T. W. Odom, J. H. Hafner, C. M. Lieber, "Scanning Probe Microscopy Studies of Carbon Nanotubes" in *Topics in Applied Physics, Vol. 80 - Carbon Nanotubes*, M. S. Dresselhaus, G. Dresselhaus, Ph. Avouris, Eds. (Springer-Verlag, Berlin, 2001).

1. A. T. Woolley, C. L. Cheung, J. H. Hafner, C. M. Lieber, "Structural Biology with Carbon Nanotube AFM Probes," *Chemistry and Biology* 7, R193 (2000).

Journal Articles (>4400 citations)

39. Y. Yang, K. M. Mayer, J. H. Hafner "Quantitative Electrostatic Mapping of Biological Interfaces by Atomic Force Microscopy", *under revision*.

38. A. Gulati, H. Liao, J. H. Hafner "Early-stage Growth Kinetics of Gold Nanorods", *Journal of Physical Chemistry B*, *in press*.

37. C. L. Nehl, H. Liao, J. H. Hafner "Biosensing with Single Gold Nanostars", *Proceedings of the SPIE*, *in press*.

36. H. Wang, Y. Wu, B. Lassiter, C. L. Nehl, J. H. Hafner, P. Nordlander, N. J. Halas, "Symmetry breaking in individual plasmonic nanoparticles", *Proceedings of the National Academy of Sciences USA* 103, p108560-10860 (2006).

35. A. Conjusteau, S. A. Ermilov, D. Lapotko, H. Liao, J. H. Hafner, M. Eghtedari, M. Motamedi, N. Kotov, A. A. Oraevsky, "Metallic nanoparticles as optoacoustic contrast agents for medical sensing", *Proceedings of the SPIE* 6086 (2006).

34. C. L. Nehl, H. Liao, J. H. Hafner, "Optical Properties of Star-shaped Gold Nanoparticles", *Nano Letters* 6, p683-688 (2006).
33. N. Wickremasinghe, J. H. Hafner, "Protein Crystal as Scanned Probes", *Nano Letters* 5, p2418-2421 (2005).
32. H. Liao, J. H. Hafner, "Gold Nanorod Bioconjugates", *Chemistry of Materials* 17, 4636-4641 (2005).
31. C. L. Nehl, N. K. Grady, G. P. Goodrich, F. Tam, N. J. Halas, J. H. Hafner, "Scattering Spectra of Single Gold Nanoshells." *Nano Letters* 4, 2355-2359 (2004).
30. H. Liao, J. H. Hafner, "Monitoring Gold Nanorod Growth on Surfaces." *Journal of Physical Chemistry B* 108, 19276-19280 (2004).
29. H. Liao, J. H. Hafner, "Low-Temperature Single-Wall Carbon Nanotube Synthesis by Thermal Chemical Vapor Deposition." *Journal of Physical Chemistry B* 108, 6941-6943 (2004).
28. A. S. Johnson, C. L. Nehl, M. G. Mason, J. H. Hafner, "Fluid electric force microscopy for charge density mapping in biological systems." *Langmuir* 19, 10007-10010 (2003).
27. D. Bozovic, M. Bockrath, J. H. Hafner, C. M. Lieber, H. Park, M. Tinkham, "Plastic deformations in mechanically strained single-wall carbon nanotubes" *Physical Review B* 67, 033407 (2003).
26. A. Jorio, F. M. Matinaga, A. Righi, M. S. S. Dantas, M. A. Pimenta, A. G. Souza, J. Mendes, J. H. Hafner, C. M. Lieber, R. Saito, G. Dresselhaus, M. S. Dresselhaus, "Resonance Raman scattering: Nondestructive and noninvasive technique for structural and electronic characterization of isolated single-wall carbon nanotubes" *Brazilian Journal of Physics* 32, 921-924 (2002).
25. A. Jorio, A.G. Souza, G. Dresselhaus, M.S. Dresselhaus, A.K. Swan, M.S. Unlu, B.B. Goldberg, M.A. Pimenta, J.H. Hafner, C.M. Lieber, R. Saito, "G-band resonant Raman study of 62 isolated single-wall carbon nanotubes" *Physical Review B* 65, 155412 (2002).
24. A. Jorio, A.G Souza, V.W. Brar, A.K. Swan, M.S. Unlu, B.B. Goldberg, A. Righi, J.H. Hafner, C.M. Lieber, R. Saito, G. Dresselhaus, M.S. Dresselhaus, "Polarized resonant Raman study of single-wall carbon nanotubes: Symmetry selection rules, dipolar and multipolar antenna effects" *Physical Review B* 65, 121402 (2002).
23. A.G. Souza, A. Jorio, G.G. Samsonidze, G. Dresselhaus, M.S. Dresselhaus, A.K. Swan, M.S. Unlu, B.B. Goldberg, R. Saito, J.H. Hafner, C.M. Lieber, M.A. Pimenta, "Probing the electronic trigonal warping effect in individual single-wall carbon nanotubes using phonon spectra" *Chemical Physics Letters* 354, 62-68 (2002).
22. A.G. Souza, A. Jorio, A.K. Swan, M.S. Unlu, B.B. Goldberg, R. Saito, J.H. Hafner, C.M. Lieber, M.A. Pimenta, G. Dresselhaus, M.S. Dresselhaus, "Anomalous two-peak

G'-band Raman effect in one isolated single-wall carbon nanotube" *Physical Review B* 65, 085417 (2002).

21. A.G. Souza, A. Jorio, G. Dresselhaus, M.S. Dresselhaus, R. Saito, A.K. Swan, M.S. Unlu, B.B. Goldberg, J.H. Hafner, C.M. Lieber, M.A. Pimenta, "Effect of quantized electronic states on the dispersive Raman features in individual single-wall carbon nanotubes" *Physical Review B* 65, 035404 (2002).

20. G. R. Schnitzler, C.L. Cheung, J.H. Hafner, A.J. Saurin, R.E. Kingston, C.M. Lieber, "Direct imaging of hSWI/SNF remodeled mono- and polynucleosomes by atomic force microscopy employing carbon nanotube tips", *Molecular and Cellular Biology* 21, 8504-8511 (2001).

19. M. A. Pimenta, A. Jorio, S. D. M. Brown, A. G. Souza, G. Dresselhaus, J. H. Hafner, C. M. Lieber, R. Saito, M. S. Dresselhaus, "Diameter dependence of the Raman D-band in isolated single-wall carbon nanotubes," *Physical Review B* 64, 041401 (2001).

18. R. Saito, A. Jorio, J. H. Hafner, C. M. Lieber, M. Hunter, T. McClure, G. Dresselhaus, M. S. Dresselhaus, "Chirality Dependent G-band Raman Intensity of Carbon Nanotubes," *Physical Review B* 64, 085312 (2001).

17. W. Liang, M. Bockrath, D. Bozovic, J. H. Hafner, M. Tinkham, H. Park, "Fabry-Perot Interference in a Nanotube Electron Waveguide," *Nature* 411, 665-669 (2001).

16. A.G. Souza Filho, A. Jorio, J.H. Hafner, C.M. Lieber, R. Saito, M.A. Pimenta, G. Dresselhaus, M.S. Dresselhaus, "Electronic transition energy E_{ii} for an isolated (n,m) single-wall carbon nanotube obtained by anti-Stokes/Stokes resonant Raman intensity ratio", *Physical Review B* 63, 241404 (2001).

15. A. Jorio, A.G. Souza Filho, G. Dresselhaus, M.S. Dresselhaus, R. Saito, J.H. Hafner, C.M. Lieber, F.M. Matinaga, M.S.S. Dantas, M.A. Pimenta "Joint density of electronic states for one isolated single-walled carbon nanotube studied by resonant Raman scattering", *Physical Review B* 63, 245416 (2001).

14. D. Bozovic, M. Bockrath, J. H. Hafner, C. M. Lieber, H. Park, M. Tinkham, "Electronic Properties of Mechanically Induced Kinks in Single-Walled Carbon Nanotubes," *Applied Physics Letters* 78, 3693- (2001).

13. A. Jorio, R. Saito, J. H. Hafner, C. M. Lieber, G. Dresselhaus, M. S. Dresselhaus, "Structural (n,m) determination of isolated single walled carbon nanotubes by resonant Raman scattering," *Physical Review Letters* 86, 1118-1121 (2001).

12. J. H. Hafner, C.L. Cheung, T. H. Oosterkamp, C. M. Lieber, "High-yield fabrication of individual single-walled nanotube probe tips for atomic force microscopy," *Journal of Physical Chemistry B* 105, 743-746 (2001).

11. M. Bockrath, W. Liang, D. Bozovic, J. H. Hafner, C. M. Lieber, M. Tinkham, H. Park, "Resonant Electron Scattering by Defects in Single-Walled Carbon Nanotubes," *Science* 291, 283-285 (2001).

10. C. L. Cheung, J. H. Hafner, T. W. Odom, K. Kim, C. M. Lieber, "Growth and fabrication with single-walled carbon nanotube probe microscopy tips," *Applied Physics Letters* 76, 3136 (2000).
9. C. L. Cheung, J. H. Hafner, C. M. Lieber, "Carbon nanotube atomic force microscopy tips: Direct growth by chemical vapor deposition and application to high-resolution imaging," *Proceedings of the National Academy of Sciences of the United States of America* 97, 3809 (2000).
8. J. H. Hafner, C. L. Cheung, and C. M. Lieber, "Direct Growth of Single-Walled Carbon Nanotube Scanning Probe Microscopy Tips," *Journal of the American Chemical Society* 121, 9750 (1999).
7. J. H. Hafner, C. L. Cheung, and C. M. Lieber, "Growth of Nanotubes as Probe Microscopy Tips," *Nature* 398, 761 (1999).
6. J. H. Hafner, M. J. Bronikowski, B. R. Azamian, P. Nikolaev, A. G. Rinzler, D. T. Colbert, K. A. Smith, and R. E. Smalley, "Catalytic Growth of Single Wall Carbon Nanotubes from Metal Particles," *Chemical Physics Letters* 296, 195 (1998).
5. J. Liu, A. G. Rinzler, H. Dai, J. H. Hafner, R. K. Bradley, A. Lu, K. Shelimov, C.B. Huffman, F. Rodriguez-Macias, P. Boul, T. Iverson, D. T. Colbert, and R. E. Smalley, "Fullerene Pipes," *Science* 280, 1253 (1998).
4. J. Liu, H. Dai, J. H. Hafner, D. T. Colbert, S. J. Tans, C. Dekker, and R. E. Smalley, "Fullerene Crop Circles," *Nature* 385, 780 (1997).
3. H. Dai, J. H. Hafner, A. G. Rinzler, D. T. Colbert, and R. E. Smalley, "Nanotubes as Nanoprobes in Scanning Probe Microscopy," *Nature* 384, 147 (1996).
2. A. G. Rinzler, J. H. Hafner, P. Nikolaev, L. Lou, S. G. Kim, D. Tomanek, P. Nordlander, D. T. Colbert, and R. E. Smalley, "Unraveling Nanotubes: Field Emission from an Atomic Wire," *Science* 269, 1550 (1995).
1. D. T. Colbert, J. Zhang, S. M. McClure, P. Nikolaev, Z. Chen, J. H. Hafner, D. W. Owens, P. G. Kotula, C. B. Carter, J. H. Weaver, A. G. Rinzler, and R. E. Smalley, "Growth and Sintering of Fullerene Nanotubes," *Science* 266, 1218 (1994).

Patents

25. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for forming a patterned array of single-wall carbon nanotubes," US Patent No. 7,108,841 September 19, 2006.
24. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Methods for producing composites of single-wall carbon nanotubes and compositions thereof," US Patent No. 7,105,596 September 12, 2006.
23. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Continuous fiber of single-wall carbon nanotubes," US Patent No. 7,097,820 August 29, 2006.

22. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for forming an array of single-wall carbon nanotubes in an electric field and compositions thereof," US Patent No. 7,087,207 August 8, 2006.
21. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Array of single-wall carbon nanotubes," US Patent No. 7,071,406 July 4, 2006.
20. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for forming an array of single-wall carbon nanotubes and compositions thereof," US Patent No. 7,067,098 June 27, 2006.
19. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for cutting single-wall carbon nanotubes," US Patent No. 7,052,666 May 30, 2006.
18. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for producing self-assembled objects comprising single-wall carbon nanotubes and compositions thereof," US Patent No. 7,048,999 May 23, 2006.
17. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Macroscopically manipulable nanoscale devices made from nanotube assemblies," US Patent No. 7,048,903 May 23, 2006.
16. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for producing a catalyst support and compositions thereof," US Patent No. 7,041,620 May 9, 2006.
15. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Continuous fiber of single-wall carbon nanotubes," US Patent No. 7,008,604 March 7, 2006.
14. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for forming composites of sub-arrays of single-wall carbon nanotubes," US Patent No. 6,986,876 January 17, 2006.
13. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Continuous fiber of single-wall carbon nanotubes," US Patent No. 6,979,709 December 27, 2005.
12. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for growing single-wall carbon nanotubes utilizing seed molecules," US Patent No. 6,949,237 September 27, 2005.
11. D. T. Colbert, H. Dai, J. H. Hafner, A. G. Rinzler, R. E. Smalley, J. Liu, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method of forming composite arrays of single-wall carbon nanotubes and compositions thereof," US Patent No. 6,939,525 September 6, 2005.

10. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for purification of as-produced single-wall carbon nanotubes," US Patent No. 6,936,233 August 30, 2005.

9. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, D. Smith, T. Guo, P. Nikolaev, A. Thess, "Carbon Fibers Formed from Single Wall Carbon Nanotubes," Canadian Patent No. 2,283,502 June 14, 2005.

8. D. T. Colbert, H. Dai, J. H. Hafner, A. G. Rinzler, R. E. Smalley, "Method for producing a catalyst support and compositions thereof," US Patent No. 6,824,755 November 30, 2004.

7. D. T. Colbert, H. Dai, J. H. Hafner, A. G. Rinzler, R. E. Smalley, K. A. Smith, J. Liu, T. Guo, P. Nikolaev, A. Thess, "Method for growing continuous carbon fiber and compositions thereof," US Patent No. 6,756,026 June 29, 2004.

6. D. T. Colbert, H. Dai, J. H. Hafner, A. G. Rinzler, R. E. Smalley, "Method for growing single-wall carbon nanotubes utilizing seed molecules," US Patent No. 6,756,025 June 29, 2004.

5. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. A. Smith, T. Guo, P. Nikolaev, A. Thess, "Method for growing continuous fiber," US Patent No. 6,749,827 June 15, 2004.

4. C. M. Lieber, J. H. Hafner, C. L. Cheung, P. Kim, "Direct growth of nanotubes, and their use in nanotweezers," US Patent No. 6,743,408 issued June 1, 2004.

3. J. H. Hafner, C. L. Cheung, C. M. Lieber, "Fabrication of nanotube microscopy tips," US Patent No 6,716,409, issued April 6, 2004.

2. R. E. Smalley, J. H. Hafner, D. T. Colbert, K. Smith, "Catalytic growth of single-wall carbon nanotubes from metal particle," US Patent No. 6,692,717, issued Feb 17, 2004.

1. R. E. Smalley, D. T. Colbert, H. Dai, J. Liu, A. G. Rinzler, J. H. Hafner, K. Smith, T. Guo, P. Nikolaev, A. Thess, "Carbon fibers formed from single-wall carbon nanotubes," US Patent No. 6,683,783, issued Jan 27, 2004.

Teaching

PHYS 537 METHODS OF EXPERIMENTAL PHYSICS I: Fall 2002, 2003, 2004.

PHYS 538 METHODS OF EXPERIMENTAL PHYSICS II: Spring 2003, 2004, 2005, 2006, 2007.

PHYS 201 WAVES AND OPTICS: Fall 2006.

Research Support

Current:

“Gold Nanorods for Targeted Gene Delivery” (Co-PI with 1 other investigator), Alliance for NanoHealth (Department of Defense), 7/1/06 – 6/30/07.

“Probing the Electrostatics of Lipid Bilayer Membranes” (PI), National Science Foundation CHE-0517937, 7/1/05 – 6/30/08.

“Chemical Kinetics of Single-Wall Carbon Nanotube Synthesis” (PI), Welch Foundation C-1556, 6/1/03 – 5/31/06.

“Core Nanomaterials for Near-Infrared Applications” (PI), Center for Biological and Environmental Nanotechnology (NSF NSEC EEC-0118007), 5/1/02 – 6/30/06.

“A Multimodality Ultramicrospectroscopy (MUMS): Imaging with Integrated Spectroscopies for Chemical and Biomolecular Identification” (Co-PI with 8 other investigators), Department of Defense OSD W911NF-04-1-0203, 6/1/04 – 5/31/09.

“IGERT: Nanophotonics: Fundamental and Applications in Emerging Technologies” (Co-PI with 4 other investigators), National Science Foundation 0504425, 7/1/05 – 6/30/10.

Past:

“Nanowells for biological atomic force microscopy” (PI), Arnold and Mabel Beckman Foundation, 7/1/02 – 6/30/05.

“Chemical Kinetics and Selective Synthesis of Carbon Nanotubes” (PI), Petroleum Research Fund 39603-G5M, 7/1/03 – 6/30/05.

University Service

Faculty Childcare Committee (2005 – present)

University Committee on the Library (2003 - present).

Faculty Enhancement Committee for the Department of Physics & Astronomy (2005 – present).

Bionanotechnology Session Chair, First Annual Institute for Biosciences and Bioengineering Symposium, Rice University, Houston, TX, July 7, 2005.

Speaker, Center for Biological and Environmental Nanotechnology Site Visit, June 15, 2005.

Sloan Prof Masters curriculum committee – helped create curriculum for new Professional Master’s in Nanoscale Physics (2001)

Shared Equipment Authority – member of this committee that manages large shared scientific equipment on campus, and serve as faculty in charge of atomic force microscopes (2001 – 2004).

University & Main Committee – served on this faculty committee to generate a report for the Provost on the potential impact of a joint Rice / Texas Medical Center research building (2002).

Graduate student admissions committee for the Applied Physics Ph.D. program (2002, 2003, 2004).

Faculty Associate at Hanzsen College (2001-2002).

Faculty Search Committees for the Department of Physics and Astronomy (2002, 2004).

Department of Physics and Astronomy Curriculum Committee (2002 – present).

Judged poster and talk competitions at the annual RQI Summer Research Colloquium (2002, 2003, 2004).

Spoke to an engineering and science delegation from the International University – Bremen to foster research collaborations, Houston, TX, January 22, 2003.

Spoke at a symposium to encourage collaborations between Texas and UK researchers in the biosciences to foster research collaborations, Houston, TX, May 12, 2003.

Spoke at the DOD MURI Kick Off meeting at Rice University, Houston, TX July 29, 2004.

Thesis committees:

Bin Gong	M.S.	Physics & Astronomy	2001
<i>“Overview of Jovian Aurora’s observed Features and its Possible Origins”</i>			
Carla Aguirre	M.S.	Applied Physics	2002
<i>“Reshaping the metallic surface of a gold nanoshell”</i>			
Cristin Moran	Ph.D.	Chemistry	2003
<i>“Fabrication of optically active nanostructures by chemical methods”</i>			
Sarah Nagel	M.S.	Physics & Astronomy	2004
<i>“A narrow linewidth diode laser system for strontium laser cooling applications”</i>			
Felicia Tam	M.S.	Applied Physics	2004
<i>“Geometrical parameters controlling sensitivity of nanoshell plasmon resonances to changes in dielectric environment”</i>			
Nathaniel Grady	M.S.	Chemistry	2004
<i>“Influence of Dielectric Function Properties on the Optical Response of Plasmon Resonant Metallic Nanoparticles”</i>			
Michael Cooke	M.S.	Physics & Astronomy	2004
<i>“Operation and Efficiency of the D0 Central Track Trigger”</i>			

Hao Yang	M.S.	Physics & Astronomy	2005
<i>"Measuring the magnetic field on the classical T Tauri star TW Hydrae"</i>			
Fei Le	M.S.	Physics & Astronomy	2005
<i>"Plasmon Hybridization"</i>			
Siyang Sun	Ph.D.	Biochemistry and Cell Biology	2005
<i>"Biochemical and crystallographic studies of bacteriophage RB69 DNA polymerase and single-stranded DNA binding protein interactions"</i>			
Surbhi Lal	Ph.D.	Applied Physics	2006
<i>"Mapping the Near field of Nanoshells using Surface Enhanced Raman Spectroscopy and Fluorescence Spectroscopy"</i>			
Paul Onti	M.S.	Physics & Astronomy	2006
<i>"A Flexible Approach to Modeling the Storm-Time Region 2 and Magnetopause Currents"</i>			
Min-Ho Lee	Ph.D.	Bioengineering	2006
<i>"Gold Nanoshells for Optical Coherence Tomography"</i>			
Nyein Zaw Lwin	M.S.	Chemistry	2006
<i>"Fabrication of Plasmonic Nanoparticle Structures on Planar Substrates"</i>			
Fan Wei	M.S.	Chemistry	2006
<i>"Explore Dye Sensitized Solar Cells Using Catecholphosphane Transition Metal"</i>			
Feng Hao	M.S.	Physics & Astronomy	2006
<i>"Plasmonic coupling between a metallic sphere and a thin metallic wire"</i>			
Daniel Brandl	M.S.	Physics & Astronomy	2006
<i>"Plasmon Hybridization"</i>			

Committee member for Nyein Zaw Lwin ECE 599 Project, April 29, 2004

Committee member for Jonh-David Rocha, Department of Chemistry PhD qualifier, February 1, 2005.

Guest lecturer on carbon nanotubes for ECE 565 TOPICS IN QUANTUM SEMICONDUCTOR NANOSTRUCTURES (2001).

Guest lecturer on nano-biophysics for PHYS 534 NANOSTRUCTURES AND NANOTECHNOLOGY II (2003, 2004).

Guest lecturer on atomic force microscopy for PHYS 539 CHARACTERIZATION AND FABRICATION AT THE NANOSCALE (2002, 2003).

Guest lecturer on atomic force microscopy for CHEM 533 NANOSTRUCTURES AND NANOTECHNOLOGY (2004, 2005).

Professional Service

Panel Member, "U.S. Measurement System Workshop on Measurement and Standards Needs in NanoBiotechnology", Rice University, January 19, 2006.

Served as the external member on Guoting Qin's qualifying examination committee at the University of Houston, December 2, 2004.

Attended and presented a poster at the 2004 Keck Futures Initiative sponsored by the National Academy of Sciences, Irvine, CA, November 18-21, 2004.

Attended and presented a poster at the Biophysical Society: Biophysical Discussions meeting, Asilomar, CA, October 18-31, 2004.

Section Presider for "Nanoparticle Enhanced Spectroscopies", a symposium organized by the Division of Condensed Matter Physics at the 2004 March meeting of the American Physical Society, March 24, 2004.

Co-Organizer of "Nanostructured Organic Materials", a symposium at the Fall 2003 Materials Research Society meeting in Boston, MA, December 1-3, 2003.

Attended and presented a poster at the 2002 Beckman Frontiers of Science Symposium sponsored by the National Academy of Sciences, Irvine, CA, November 14-16, 2002.

Reviewed grant proposal for:

Petroleum Research Foundation of the American Chemical Society
National Science Foundation - National Science and Engineering Centers
National Science Foundation – Major Research Instrumentation

Reviewed manuscripts for:

Advanced Materials
Applied Physics Letters
Chemical Physics Letters
Journal of the American Chemical Society
Journal of Physical Chemistry B
Langmuir
Nano Letters
Nanotechnology

Students Supervised

Graduate:

Amber Johnson (Applied Physics), M.S. Fall 2003, currently a beam line operator at Fermilab.

Hongwei Liao (Chemistry), M.S., May 2004.

Colleen Nehl (Physics & Astronomy), M.S., July 2004.

Yi Yang (Physics & Astronomy), M.S. July 2006.

Nissanka Wickremasinghe (Physics & Astronomy), M.S., September 2005.

Katherine Mayer (Physics & Astronomy), second year graduate student

Seung Hyun (Chemistry), first year graduate student

Betty Rostro (Applied Physics)

Undergraduate:

Monica Mason (Physics & Astronomy), Master's Program in Environmental Science and Engineering, Ecole Polytechnique Federale de Lausanne, Switzerland.

Katherine Mayer (Physics & Astronomy), now in graduate school at Rice University.

Amneet Gulati (Chemistry), sophomore student.

Peter Scully (Physics & Astronomy), RUSP student.

Amaris Fuentes (Biochemistry & Cell Biology), IGERT REU