

## Curriculum Vitae

### Jason H. Hafner

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- EDUCATION**
- |      |                 |                    |
|------|-----------------|--------------------|
| 1998 | Ph.D. (Physics) | Rice University    |
| 1996 | M.S. (Physics)  | Rice University    |
| 1993 | B.S. (Physics)  | Trinity University |
- POSITIONS**
- |                |  |
|----------------|--|
| 2008 – present | Associate Professor, Department of Physics & Astronomy, Rice University        |
| 2004 – present | Associate Director, Laboratory for Nanophotonics, Rice University              |
| 2001 – 2008    | Assistant Professor, Department of Physics & Astronomy, Rice University        |
| 1998 – 2001    | Postdoctoral Fellow, Dept. of Chemistry & Chemical Biology, Harvard University |
- HONORS AND AWARDS**
- 2008 Hamill Innovation Award, Institute for Biosciences and Bioengineering, Rice University
  - 2007 Brown Teaching Grant, Rice University
  - 2005 Smalley-Curl Innovation Award, Rice University
  - 2002 Beckman Young Investigator
  - 1999 NIH National Research Service Award
  - 1998 H. A. Wilson Award for outstanding Ph.D. thesis
- RESEARCH INTERESTS**
- Synthesis and optical properties of gold nanoparticles with complex shapes.
  - Biological and biomedical applications of plasmon resonant nanoparticles.
  - Interfacial electrostatics of lipid bilayer membranes.
  - The impossible.
- AFFILIATIONS**
- American Chemical Society
  - Rice Quantum Institute, Rice University
  - Laboratory for Nanophotonics, Rice University
  - Institute for Biosciences and Bioengineering, Rice University
  - Center for Biological and Environmental Nanotechnology, Rice University
- COURSES TAUGHT**
- PHYS 537 – Methods of Experimental Physics I Fall 2002, 2003, 2004
  - PHYS 538 – Methods of Experimental Physics II, Spring 2003, 2004, 2005, 2006, 2007, 2008, 2009
  - PHYS 201 – Waves and Optics, Fall 2006, 2007, 2008, 2009
- PROFESSIONAL ACTIVITIES**
- Member, NIH CSR special emphasis panel ZRG1 BST-G: Assays, Detectors, and Devices, Washington, DC, 2009.
  - Participant, The Academy of Medicine, Engineering, and Science of Texas conference, Dallas, TX 2009.
  - Panel Member, U.S. Measurement System Workshop on Measurement and Standards Needs in NanoBiotechnology”, Houston, TX, 2006.
  - Participant, Keck Futures Initiative, National Academy of Sciences, Irvine, CA, 2004.
  - Symposium Co-Organizer, Nanostructured Organic Materials, MRS meeting, Boston, MA, 2003.
  - Participant, Beckman Frontiers of Science Symposium, Irvine, CA, 2002.
  - Manuscript Referee: Advanced Materials, ACS Nano, Applied Physics Letters, Biophysical Journal, Chemical Physics Letters, Chemistry of Materials, Journal of the American Chemical Society, Journal of Physical Chemistry B, Langmuir, Nano Letters, Nanotechnology

## UNIVERSITY SERVICE

- P&A Educational Assessment Committee (2007)
- Faculty Childcare Committee (2005 – 2007)
- Long Range Planning Committee for the Department of Physics & Astronomy (2007)
- Curriculum Committee for the Department of Physics and Astronomy (2002 – 2007)
- Faculty Enhancement Committee for the Department of Physics & Astronomy (2005)
- Faculty Search Committees for the Department of Physics and Astronomy (2002, 2004, 2008)
- Faculty Search Committee for the Department of Chemistry (2007)
- Faculty Search Committee for the Dept. of Electrical and Computer Engineering (2007)
- Graduate student admissions committee for the Applied Physics Ph.D. program (2002, 2003, 2004).
- 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 – 2005).
- Sloan Prof Masters curriculum committee – helped create curriculum for new Professional Master’s in Nanoscale Physics (2001)
- University & Main Committee – served on this faculty committee to advise the Provost on the potential impact of a joint Rice / Texas Medical Center research building (2002).
- Bionanotechnology Session Chair, First Annual Institute for Biosciences and Bioengineering Symposium, Rice University, Houston, TX, July 7, 2005.
- Faculty Associate at Hanzsen College (2001-2002).
- Panel member for ADVANCE Negotiating the Ideal Faculty Position (2007, 2008).
- 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).
- Guest lecturer for PHYS 302 INTERMEDIATE ELECTRODYNAMICS (2008)

### •Thesis committees and Qualifying Exams

*Bin Gong*, M.S. 2001, Physics and Astronomy; *Carla Aguirre*, M.S. 2001, Applied Physics; *Cristin Moran*, Ph.D. 2003, Chemistry; *Sarah Nagel*, M.S. 2004, Physics and Astronomy; *Felicia Tam*, M.S. 2004, Applied Physics; *Nathaniel Grady*, M.S. 2004, Chemistry; *Michael Cooke*, M.S. 2004, Physics and Astronomy; *Hao Yang*, M.S. 2005, Physics and Astronomy; *John-David Rocha*, M.S. 2005, Chemistry; *Fei Le*, M.S. 2005, Physics and Astronomy; *Siyang Sun*, Ph.D. 2005, Biochemistry and Cell Biology; *Surbhi Lal*, Ph.D. 2006, Applied Physics; *Paul Ontiveros*, M.S. 2006, Physics and Astronomy; *Min-Ho Lee*, Ph.D. 2006, Bioengineering; *Nyein Zaw Lwin*, M.S. 2006, Chemistry; *Fan Wei*, M.S. 2006, Chemistry; *Feng Hao*, M.S. 2006, Physics and Astronomy; *Daniel Brandl*, M.S. 2006, Physics and Astronomy; *Gary Kilper*, M.S. 2006, Physics and Astronomy; *Jeffrey Dumoit*, M.S. 2006, Physics and Astronomy ; *Hongwei Liao*, Ph.D. 2006, Chemistry; *Madhu Thalukulam*, Ph.D. 2007, Physics and Astronomy; *Felicia Tam*, Ph.D. 2007, Physics and Astronomy; *Kathryn Mayer*, M.S. 2007, Physics and Astronomy ; *Kristjan Stone*, M.S. 2007, Physics and Astronomy; *Colleen Nehl*, Ph.D. 2007, Physics and Astronomy; *Fu Kun*, Ph.D. 2007, Bioengineering; *Albert Chang*, M.S. 2007, Electrical and Computer Engineering; *John-David Rocha*, Ph.D. 2007, Chemistry; *Sean Pheasant*, Ph.D. 2007; Chemistry; *Andre Gobin*, Ph.D. 2007, Bioengineering; *Daniel Brandl*, M.S. 2007, Physics and Astronomy; *Sean Lee*, M.S. 2008, Chemistry; *Alexandra Fursina*, M.S. 2008, Chemistry; *Shuo Qian*, M.S. 2008, Physics and Astronomy; *Britt Lassiter*, M.S. 2008, Physics and Astronomy; *Kenneth Wilson*, Ph.D. 2008, Mechanical Engineering and Materials Science; *Fei Le*, Ph.D. 2008, Physics and Astronomy; *Lissett Bickford*, M.S. 2008, Bioengineering; *Laura McJilton*, Ph.D. 2008, Chemistry; *Wangchen Wang*, Ph.D. 2008, Physics and Astronomy; *Emily Day*, M.S. 2008, Bioengineering; *Jorge Zuloaga*, M.S. 2009, Physics and Astronomy; *Eric Botello*, M.S. 2009, Physics and Astronomy; *Kui Bao*, M.S. 2009, Physics and Astronomy; *Richard Schwarz*, M.S. 2009, Bioengineering; *Yen Sun*, M.S. 2009, Physics and Astronomy; *Yi Yang*, Ph.D. 2009, Physics and Astronomy; *Jennifer Garner*, M.S. 2009, Bioengineering; *Shuo Qian*, Ph.D. 2009, Physics and Astronomy; *Britain Willingham*, M.S. 2009, Physics and Astronomy; *Tae-Ho Park*, M.S. 2009, Physics & Astronomy; *Nissanka Wickremasinghe*, Ph.D. 2009, Physics and Astronomy;

## STUDENTS SUPERVISED

### Graduate

1. Amber Johnson (Applied Physics), M.S. Fall 2003, currently a beam line operator at Fermilab.
2. Hongwei Liao (Chemistry), M.S. May 2004, Ph.D. December 2006, currently postdoc at UIUC
3. Colleen Nehl (Physics & Astronomy), M.S. July 2004, Ph.D. May 2007, currently a postdoc at Northwestern University.
4. Yi Yang (Physics & Astronomy), M.S. July 2006, Ph.D. May 2009, currently a research engineer at Schlumberger.
5. Nissanka Wickremasinghe (Physics & Astronomy), M.S. September 2005.
6. Kathryn Mayer (Physics & Astronomy), M.S. April 2007.
7. Seung Hyun Lee (Chemistry), M.S. May 2008.
8. Betty Rostro (Applied Physics).
9. Lindsey Anderson (Applied Physics), second year grad student.

### Undergraduate

1. Monica Mason (Rice Physics & Astronomy), Master's Program in Environmental Science and Engineering, EPFL.
2. Kathryn Mayer (Rice Physics & Astronomy), now in graduate school at Rice University.
3. Amneet Gulati (Rice Chemistry), junior, BS expected 2008.
4. Peter Scully (Rice Physics & Astronomy), senior, BS 2007, attending Baylor College of Medicine.
5. Amaris Fuentes (Rice Biochemistry & Cell Biology), junior.
6. Courtney Payne (Rice Physics & Astronomy), junior.
7. Robbie Fraleigh (Rice Physics & Astronomy), junior.
8. Adrian Delgado (UT Pan Am Physics), sophomore.

## INVITED TALKS

1. "Carbon Nanotubes as Scanning Force Microscopy Probe Tips," Trinity University Physics Department Seminar, San Antonio, TX, November 21, 1996.
2. "Carbon Nanotube Atomic Force Microscopy Probes," Brandeis University Condensed Matter Seminar, Waltham, MA, February 16, 2000.
3. "Carbon Nanotube as Atomic Force Microscopy Probes," University of Massachusetts at Lowell Physics Colloquium, Lowell, MA, September 20, 2000.
4. "Single-walled carbon nanotubes as probes in atomic force microscopy," University of California at Berkeley Condensed Matter Physics Seminar, Berkeley, CA, November 13, 2000.
5. "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.
6. "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.
7. "Carbon Nanotubes: Properties, Synthesis, and Applications," University of Houston Organic Chemistry Seminar, Houston, TX, September 17, 2001.
8. "Probing biology with atomic force microscopy" Biochemistry and Cell Biology Seminar, Rice University, Houston, TX, April 1, 2002.
9. "Three bad ways to make nanotube tips and one good one," Seminar at Digital Instruments, Santa Barbara, CA, October 29, 2002.
10. "Microscopic Measurements of Nanotube Growth and Nucleation Rates," NASA-Rice Workshop on Single-Wall Nanotube Growth Mechanisms, San Antonio, TX, February 28, 2003.
11. "Imaging Single Biomolecules with Nanotube Probes" 225<sup>th</sup> American Chemical Society National Meeting, New Orleans, LA, March 24, 2003.
12. "Single-wall carbon nanotube synthesis and applications", Physics Colloquium, Sam Houston State University, Huntsville, TX, April 29, 2003.
13. "Single-wall carbon nanotube synthesis and applications", Nanotechnology Seminar Series, GE Global Research, Piscataway, NY, May 16, 2003.
14. "Nanoscale Charge Density Mapping in Biological Systems" Physics Seminar, Trinity University, Oct. 7, 2003.
15. "Imaging at the single molecule scale with carbon nanotubes" Federation of Analytical Chemistry and Spectroscopy Societies Conference, Ft. Lauderdale, FL, Oct. 21, 2003.
16. "Biological Applications of Plasmon Resonant Nanoparticles", University of Utah Physics Colloquium, Salt Lake City, UT, March 10, 2005.
17. "Gold Nanorod Bioconjugates" 207<sup>th</sup> Electrochemical Society Meeting, Quebec City, Quebec, Canada, May 15, 2005.
18. "Specific and Nonspecific Interactions in Biological Atomic Force Microscopy", Beckman Young Investigator Symposium, Irvine, CA, August 27, 2005.

19. "Gold Nanorods and Nanostars for Localized Surface Plasmon Resonance Biosensing", Photonic Nanosystems 2005, San Francisco, CA, November 8, 2005.
20. "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.
21. "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.
22. "Localized Surface Plasmon Resonance Sensing with Gold Nanorods and Nanostars", Biomedical Engineering Seminar, Texas A&M University, College Station, TX, February 13, 2006.
23. "Electrostatic and Recognition interactions in the Atomic Force Microscope", Bioanalytical Chemistry Seminar, U. Wisconsin, Madison, WI, February 23, 2006.
24. "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.
25. "Electrostatic and Recognition interactions in the Atomic Force Microscope", Chemistry Colloquium, Ohio University, Athens, OH, May 24, 2006.
26. "Plasmon Resonances in Structurally Complex Gold Nanoparticles", Condensed Matter and Surface Science Colloquium, Ohio University, Athens OH, May 25, 2006.
27. "Bioplasmonics with Gold Nanorods and Nanostars", Late News Presentation, Gordon Research Conference on Plasmonics, Keene, New Hampshire, July 27, 2006.
28. "Biosensing with localized surface plasmon resonances in single gold nanostars", 62nd Southwest Regional Meeting of the American Chemical Society, Houston, TX, October 19, 2006.
29. "Probing Membrane Electrostatics", Department of Materials Science and Engineering Seminar, Massachusetts Institute of Technology, Cambridge, MA, October 25, 2006.
30. "Synthesis, Optics, and Applications of Plasmon Resonant Gold Nanoparticles", Physical Chemistry Seminar, Harvard University, Cambridge, MA, October 26, 2006.
31. "Plasmon Resonances in Structurally Complex Gold Nanoparticles", ECE seminar, University of Rochester, Rochester, NY, November 2, 2006.
32. "Gold Nanorod Substrates for Localized Surface Plasmon Resonance Sensing", Biennial Meeting of the International Society for Molecular Recognition, New York, NY, July 10, 2007.
33. "Biosensing with Plasmon Resonances: From Substrates to Single Particles", Gordon Research Conference on Chemistry of Electronic Materials, Mount Holyoke College, South Hadley, MA, July 24, 2007.
34. "Biosensing with localized surface plasmon resonances in single gold nanostars", SPIE Optics and Photonics 2007, San Diego, CA, August 29, 2007.
35. "Biomedical Applications of Plasmon Resonant Gold Nanoparticles", MDACC Dept. of Cancer Biology and Cancer Metastasis Research Center Seminar Series, Houston, TX, February 12, 2008.
36. "Biomedical Applications of Plasmon Resonant Nanoparticles", Houston Society for Engineering in Medicine and Biology 25<sup>th</sup> Annual Conference, Houston, TX, February 8, 2008.
37. "Biomedical Applications of Plasmon Resonant Gold Nanoparticles", Center for Nanomagnetic Systems Colloquium, University of Houston, Houston, TX, March 7, 2008.
38. "Biological Sensing with Localized Surface Plasmon Resonances", Materials Research Society Spring Meeting, San Francisco, CA, March 27, 2008.
39. "Biological Applications of Plasmon Resonant Nanoparticles", Nanobiology Training Program Summer Symposium, Houston, TX, July 15, 2008.
40. "Biological sensing with localized surface plasmon resonances", Advances in Nanomedicine Symposium, 236<sup>th</sup> National Meeting of the American Chemical Society, Philadelphia, PA, August 18, 2008.
41. "Biological sensing with localized surface plasmon resonances", plenary lecture, University of Minnesota Center for Nanostructure Applications Workshop, Minneapolis, MN, November 13, 2008.
42. "Probing the Lipid Membrane Dipole Potential", Gulf Coast Consortium for Membrane Biology Symposium, Houston, TX, January 16, 2009.
43. "Synthesis, Optics, and Biological Applications of Plasmon Resonant Gold Nanoparticles", 2<sup>nd</sup> Symposium of the Asian Research Network, Seoul, South Korea, May 17, 2009.

#### **CONTRIBUTED PRESENTATIONS**

1. "Growth of Carbon Nanotube AFM Tips by Chemical Vapor Deposition" Seattle '99: Scanning Probe Microscopy, Cantilever Sensors, and Nanostructures, Seattle, WA, May 30, 1999.
2. "Growth of high resolution carbon nanotube scanning probe microscopy tips by chemical vapor deposition" Materials Research Society Fall Meeting, Boston, MA, December 1, 1999.

3. "Carbon nanotube atomic force microscopy tips produced by chemical vapor deposition" NanoSpace 2000, Houston, TX, April 4, 2000.
4. "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.
5. "Individual single-walled nanotube tips for atomic force microscopy" Materials Research Society Fall Meeting, Boston, MA, November 28, 2000.
6. "Microscopic growth rate measurements in single-walled carbon nanotube synthesis by chemical vapor deposition" American Physical Society March Meeting, Seattle, WA, March 12, 2001.
7. "Probing Biology with the Atomic Force Microscope" NanoVivo Conference, Houston, TX, July 31, 2002.
8. "Nanoscale charge density mapping in biological systems" First annual meeting of SPRING, Austin, TX, August, 27, 2003.
9. "Atomic Force Microscopy and Spectroscopy of Biomembranes" Texas Nano Summit, Houston, TX, July, 2003.
10. "Fluid Electric Force Microscopy for Nanometer Scale Charge Density Mapping in Biological Systems" NanoDays 2003, Houston, TX, Oct. 13, 2003.
11. "Fluid Electric Force Microscopy for Nanometer Scale Charge Density Mapping in Biological Systems" Biophysical Society Annual Meeting, Baltimore, MD, Feb. 18, 2004.
12. "Scattering Spectra of Single Gold Nanoshells" American Physical Society March Meeting, Montreal, Quebec, Canada, March 24, 2004.
13. "Gold Nanorod Bioconjugates", Biophysical Society Annual Meeting, Long Beach, CA, Feb. 18, 2005.
14. "Biological Applications of Plasmon Resonant Nanoparticles", Baylor College of Medicine Directors Initiative in Translational Research, Houston, TX, March 14, 2005.
15. "Protein Crystal Tips for Bio-Recognition Atomic Force Microscopy", American Physical Society March Meeting, Los Angeles, CA, March 21, 2005.
16. "Protein Crystals as Scanned Probes", Cancun 2005: Scanning Probe Microscopy, Sensors, and Nanostructures, Cancun, Mexico June 5, 2005.
17. "Probing Membrane Electrostatics with the Atomic Force Microscope", Seeing at the Nanoscale V, Santa Barbara, CA, June 25, 2007.

#### **PUBLICATIONS** (>7600 citations, $h = 32$ )

##### Journal Articles

1. Colbert, D. T.; Zhang, J.; McClure, S. M.; Nikolaev, P.; Chen, Z.; Hafner, J. H.; Owens, D. W.; Kotula, P. G.; Carter, C. B.; Weaver, J. H.; Rinzler, A. G.; Smalley, R. E., Growth and Sintering of Fullerene Nanotubes. *Science* **1994**, 266, (5188), 1218-1222.
2. Rinzler, A. G.; Hafner, J. H.; Nikolaev, P.; Lou, L.; Kim, S. G.; Tomanek, D.; Nordlander, P.; Colbert, D. T.; Smalley, R. E., Unraveling Nanotubes - Field-Emission from an Atomic Wire. *Science* **1995**, 269, (5230), 1550-1553.
3. Dai, H. J.; Hafner, J. H.; Rinzler, A. G.; Colbert, D. T.; Smalley, R. E., Nanotubes as nanoprobe in scanning probe microscopy. *Nature* **1996**, 384, (6605), 147-150.
4. Liu, J.; Dai, H. J.; Hafner, J. H.; Colbert, D. T.; Smalley, R. E.; Tans, S. J.; Dekker, C., Fullerene 'crop circles'. *Nature* **1997**, 385, (6619), 780-781.
5. Hafner, J. H.; Bronikowski, M. J.; Azamian, B. R.; Nikolaev, P.; Rinzler, A. G.; Colbert, D. T.; Smith, K. A.; Smalley, R. E., Catalytic growth of single-wall carbon nanotubes from metal particles. *Chemical Physics Letters* **1998**, 296, (1-2), 195-202.
6. Liu, J.; Rinzler, A. G.; Dai, H. J.; Hafner, J. H.; Bradley, R. K.; Boul, P. J.; Lu, A.; Iverson, T.; Shelimov, K.; Huffman, C. B.; Rodriguez-Macias, F.; Shon, Y. S.; Lee, T. R.; Colbert, D. T.; Smalley, R. E., Fullerene pipes. *Science* **1998**, 280, (5367), 1253-1256.
7. Hafner, J. H.; Cheung, C. L.; Lieber, C. M., Direct growth of single-walled carbon nanotube scanning probe microscopy tips. *Journal of the American Chemical Society* **1999**, 121, (41), 9750-9751.
8. Hafner, J. H.; Cheung, C. L.; Lieber, C. M., Growth of nanotubes for probe microscopy tips. *Nature* **1999**, 398, (6730), 761-762.
9. Cheung, C. L.; Hafner, J. H.; Lieber, C. M., 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* **2000**, 97, (8), 3809-3813.
10. Cheung, C. L.; Hafner, J. H.; Odom, T. W.; Kim, K.; Lieber, C. M., Growth and fabrication with single-walled carbon nanotube probe microscopy tips. *Applied Physics Letters* **2000**, 76, (21), 3136-3138.
11. Bockrath, M.; Liang, W. J.; Bozovic, D.; Hafner, J. H.; Lieber, C. M.; Tinkham, M.; Park, H. K., Resonant electron scattering by defects in single-walled carbon nanotubes. *Science* **2001**, 291, (5502), 283-285.
12. Bozovic, D.; Bockrath, M.; Hafner, J. H.; Lieber, C. M.; Park, H.; Tinkham, M., Electronic properties of mechanically induced kinks in single-walled carbon nanotubes. *Applied Physics Letters* **2001**, 78, (23), 3693-3695.

13. Hafner, J. H.; Cheung, C. L.; Oosterkamp, T. H.; Lieber, C. M., High-yield assembly of individual single-walled carbon nanotube tips for scanning probe microscopies. *Journal of Physical Chemistry B* **2001**, 105, (4), 743-746.
14. Jorio, A.; Saito, R.; Hafner, J. H.; Lieber, C. M.; Hunter, M.; McClure, T.; Dresselhaus, G.; Dresselhaus, M. S., Structural (n, m) determination of isolated single-wall carbon nanotubes by resonant Raman scattering. *Physical Review Letters* **2001**, 86, (6), 1118-1121.
15. Jorio, A.; Souza, A. G.; Dresselhaus, G.; Dresselhaus, M. S.; Saito, R.; Hafner, J. H.; Lieber, C. M.; Matinaga, F. M.; Dantas, M. S. S.; Pimenta, M. A., Joint density of electronic states for one isolated single-wall carbon nanotube studied by resonant Raman scattering. *Physical Review B* **2001**, 6324, (24), -.
16. Pimenta, M. A.; Jorio, A.; Brown, S. D. M.; Souza, A. G.; Dresselhaus, G.; Hafner, J. H.; Lieber, C. M.; Saito, R.; Dresselhaus, M. S., Diameter dependence of the Raman D-band in isolated single-wall carbon nanotubes. *Physical Review B* **2001**, 6404, (4), -.
17. Saito, R.; Jorio, A.; Hafner, J. H.; Lieber, C. M.; Hunter, M.; McClure, T.; Dresselhaus, G.; Dresselhaus, M. S., Chirality-dependent G-band Raman intensity of carbon nanotubes. *Physical Review B* **2001**, 6408, (8), art. no.-085312.
18. Schnitzler, G. R.; Cheung, C. L.; Hafner, J. H.; Saurin, A. J.; Kingston, R. E.; Lieber, C. M., Direct imaging of human SWI/SNF-remodeled mono- and polynucleosomes by atomic force microscopy employing carbon nanotube tips. *Molecular and Cellular Biology* **2001**, 21, (24), 8504-8511.
19. Souza, A. G.; Jorio, A.; Hafner, J. H.; Lieber, C. M.; Saito, R.; Pimenta, M. A.; Dresselhaus, G.; Dresselhaus, M. S., Electronic transition energy E<sub>ii</sub> for an isolated (n,m) single-wall carbon nanotube obtained by anti-Stokes/Stokes resonant Raman intensity ratio. *Physical Review B* **2001**, 6324, (24), -.
20. Jorio, A.; Matinaga, F. M.; Righi, A.; Dantas, M. S. S.; Pimenta, M. A.; Souza, A. G.; Mendes, J.; Hafner, J. H.; Lieber, C. M.; Saito, R.; Dresselhaus, G.; Dresselhaus, M. S., Resonance Raman scattering: Nondestructive and noninvasive technique for structural and electronic characterization of isolated single-wall carbon nanotubes. *Brazilian Journal of Physics* **2002**, 32, (4), 921-924.
21. Jorio, A.; Souza, A. G.; Brar, V. W.; Swan, A. K.; Unlu, M. S.; Goldberg, B. B.; Righi, A.; Hafner, J. H.; Lieber, C. M.; Saito, R.; Dresselhaus, G.; Dresselhaus, M. S., Polarized resonant Raman study of isolated single-wall carbon nanotubes: Symmetry selection rules, dipolar and multipolar antenna effects. *Physical Review B* **2002**, 65, (12), -.
22. Souza, A. G.; Jorio, A.; Dresselhaus, G.; Dresselhaus, M. S.; Saito, R.; Swan, A. K.; Unlu, M. S.; Goldberg, B. B.; Hafner, J. H.; Lieber, C. M.; Pimenta, M. A., Effect of quantized electronic states on the dispersive Raman features in individual single-wall carbon nanotubes. *Physical Review B* **2002**, 65, (3), -.
23. Souza, A. G.; Jorio, A.; Samsonidze, G. G.; Dresselhaus, G.; Dresselhaus, M. S.; Swan, A. K.; Unlu, M. S.; Goldberg, B. B.; Saito, R.; Hafner, J. H.; Lieber, C. M.; Pimenta, M. A., Probing the electronic trigonal warping effect in individual single-wall carbon nanotubes using phonon spectra. *Chemical Physics Letters* **2002**, 354, (1-2), 62-68.
24. Souza, A. G.; Jorio, A.; Swan, A. K.; Unlu, M. S.; Goldberg, B. B.; Saito, R.; Hafner, J. H.; Lieber, C. M.; Pimenta, M. A.; Dresselhaus, G.; Dresselhaus, M. S., Anomalous two-peak G'-band Raman effect in one isolated single-wall carbon nanotube. *Physical Review B* **2002**, 65, (8).
25. Bozovic, D.; Bockrath, M.; Hafner, J. H.; Lieber, C. M.; Park, H.; Tinkham, M., Plastic deformations in mechanically strained single-walled carbon nanotubes. *Physical Review B* **2003**, 67, (3), -.
26. Johnson, A. S.; Nehl, C. L.; Mason, M. G.; Hafner, J. H., Fluid electric force microscopy for charge density mapping in biological systems. *Langmuir* **2003**, 19, (24), 10007-10010.
27. Liao, H. W.; Hafner, J. H., Monitoring gold nanorod synthesis on surfaces. *Journal of Physical Chemistry B* **2004**, 108, (50), 19276-19280.
28. Liao, H. W.; Hafner, J. H., Low-temperature single-wall carbon nanotube synthesis by thermal chemical vapor deposition. *Journal of Physical Chemistry B* **2004**, 108, (22), 6941-6943.
29. Nehl, C. L.; Grady, N. K.; Goodrich, G. P.; Tam, F.; Halas, N. J.; Hafner, J. H., Scattering spectra of single gold nanoshells. *Nano Letters* **2004**, 4, (12), 2355-2359.
30. Liao, H. W.; Hafner, J. H., Gold nanorod bioconjugates. *Chemistry of Materials* **2005**, 17, (18), 4636-4641.
31. Wickremasinghe, N. S.; Hafner, J. H., Protein crystals as scanned probes for recognition atomic force microscopy. *Nano Letters* **2005**, 5, (12), 2418-2421.
32. Gulati, A.; Liao, H.; Hafner, J. H., Monitoring gold nanorod synthesis by localized surface plasmon resonance. *Journal of Physical Chemistry B* **2006**, 110, (45), 22323-22327.
33. Nehl, C. L.; Liao, H. W.; Hafner, J. H., Optical properties of star-shaped gold nanoparticles. *Nano Letters* **2006**, 6, (4), 683-688.
34. Wang, H.; Wu, Y. P.; Lassiter, B.; Nehl, C. L.; Hafner, J. H.; Nordlander, P.; Halas, N. J., Symmetry breaking in individual plasmonic nanoparticles. *Proceedings of the National Academy of Sciences of the United States of America* **2006**, 103, (29), 10856-10860.
35. Hao, F.; Nehl, C. L.; Hafner, J. H.; Nordlander, P., Plasmon resonances of a gold nanostar. *Nano Letters* **2007**, 7, (3), 729-732.
36. Yang, Y.; Mayer, K. M.; Hafner, J. H., Quantitative membrane electrostatics with the atomic force microscope. *Biophysical Journal* **2007**, 92, (6), 1966-1974.

37. Hleb, E. Y.; Hafner, J. H.; Myers, J. N.; Hanna, E. Y.; Rostro, B. C.; Zhdanok, S. A.; Lapotko, D. O., LANTCET: elimination of solid tumor cells with photothermal bubbles generated around clusters of gold nanoparticles. *Nanomedicine* **2008**, 3, (5), 647-667.
38. Hleb, E. Y.; Hu, Y.; Drezek, R. A.; Hafner, J. H.; Lapotko, D. O., Photothermal bubbles as optical scattering probes for imaging living cells. *Nanomedicine* **2008**, 3, (6), 797-812.
39. Lassiter, J. B.; Aizpurua, J.; Hernandez, L. I.; Brandl, D. W.; Romero, I.; Lal, S.; Hafner, J. H.; Nordlander, P.; Halas, N. J., Close encounters between two nanoshells. *Nano Letters* **2008**, 8, (4), 1212-1218.
40. Mayer, K. M.; Lee, S.; Liao, H.; Rostro, B. C.; Fuentes, A.; Scully, P. T.; Nehl, C. L.; Hafner, J. H., A label-free immunoassay based upon localized surface plasmon resonance of gold nanorods. *ACS Nano* **2008**, 2, (4), 687-692.
41. Yang, Y.; Mayer, K. M.; Wickremasinghe, N. S.; Hafner, J. H., Probing the Lipid Membrane Dipole Potential by Atomic Force Microscopy. *Biophysical Journal* **2008**, 95, (11), 5193-5199.
42. Lee, S.; Mayer, K. M.; Hafner, J. H. An Improved Localized Surface Plasmon Resonance Immunoassay with Gold Bipyramid Substrates. *Analytical Chemistry* **2009**, 81, 4450-4455.
43. Rostro-Kohanloo, B.C.; Bickford, L. R.; Payne, C. M.; Day, E. S.; Anderson, L. J. E.; Zhong, M.; Lee, S.; Mayer, K. M.; Zal, T.; Adam, L.; Dinney, C. P. N.; Drezek, R. A.; West, J. L.; Hafner, J. H. Stabilization and Targeting of Surfactant-Synthesized Gold Nanorods. *Nanotechnology*, under revision.

#### Review Articles

44. Woolley, A. T.; Cheung, C. L.; Hafner, J. H.; Lieber, C. M., Structural biology with carbon nanotube AFM probes. *Chemistry & Biology* **2000**, 7, (11), R193-R204.
45. Hafner, J. H.; Cheung, C. L.; Woolley, A. T.; Lieber, C. M., Structural and functional imaging with carbon nanotube AFM probes. *Progress in Biophysics & Molecular Biology* **2001**, 77, (1), 73-110.
46. Liao, H. W.; Nehl, C. L.; Hafner, J. H., Biomedical applications of plasmon resonant metal nanoparticles. *Nanomedicine* **2006**, 1, (2), 201-208.
47. Nehl, C. L.; Hafner, J. H., Shape-dependent plasmon resonances of gold nanoparticles. *Journal of Materials Chemistry* **2008**, 18, (21), 2415-2419.

#### Book Chapters

48. Odom, T. W., 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: 2001.
49. Hafner, J. H., Probes in Scanning Microscopies. In *Nanotribology and Nanomechanics: An Introduction*, Bhushan, Ed. Springer-Verlag: 2005.
50. Hafner, J. H., Probes in Scanning Microscopies. In *Springer Nano Handbook*, Bhushan, Ed. Springer-Verlag: 2004.

#### Other Articles

51. Hafner, J. H. "Richard E. Smalley", *Physics Today*, May 2006.
52. Hafner, J. H. "Plasmonics – Gold Nanoparticles are Shaped for Effect," *Laser Focus World*, April 2006.

#### **PATENTS**

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.
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.
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.
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.
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.
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.
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.
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.
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.

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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
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.
26. 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 for purification of as-produced single-wall carbon nanotubes," US Patent No. 7,115,864 October 3, 2006.
27. R. E. Smalley, J. H. Hafner, D. T. Colbert, K. A. Smith, "Catalytic growth of single- and double-wall carbon nanotubes from metal particles," US Patent No. 7,125,534 October 24, 2006.
28. R. E. Smalley, J. H. Hafner, D. T. Colbert, K. A. Smith, "Ropes comprised of single-walled and double-walled carbon nanotubes," US Patent No. 7,150,864 December 19, 2006.
30. 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, "Membrane comprising of an array of single-wall carbon nanotubes," US Patent No. 7,205,069 April 17, 2007

## **EXTERNAL RESEARCH SUPPORT**

### Current

1. "IGERT: Nanophotonics: Fundamental and Applications in Emerging Technologies" (Co-PI with 4 other investigators), National Science Foundation 0504425, 7/1/05 – 6/30/10.
2. "Photothermal Method for Diagnostics and Selective Nanothermolysis of Superficial Tumors" (Lapotko and Hafner PI's), National Institutes of Health R21, 4/1/2009 – 5/31/2011.

### Past

1. "Nanowells for biological atomic force microscopy" (PI), Arnold and Mabel Beckman Foundation, 7/1/02 – 6/30/05.
2. "Chemical Kinetics and Selective Synthesis of Carbon Nanotubes" (PI), Petroleum Research Fund 39603-G5M, 7/1/03 – 6/30/05.
3. "Probing the Electrostatics of Lipid Bilayer Membranes" (PI), National Science Foundation CHE-0517937, 7/1/05 – 6/30/08.
4. "Chemical Kinetics of Gold Nanorod Synthesis" (PI), Welch Foundation C-1556, 6/1/06 – 5/31/09.
5. "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.
6. "Feasibility of selective laser elimination of leukemia cells targeted with gold and silver nanorods" (Co-PI with 3 other investigators), Alliance for NanoHealth (Department of Defense), 2/1/07 – 1/31/08.
7. "Gold Nanorods for Targeted Gene Delivery" (Co-PI with 1 other investigator), Alliance for NanoHealth (Department of Defense), 2/1/07 – 1/31/08.