

Rodney S. Ruoff

Education

- 1988 Ph.D. Chemical Physics, University of Illinois-Urbana
Thesis: "Fourier-Transform Microwave Spectroscopy of Hydrogen-bonded Trimers and of Conformer Relaxation in Free Jets"
(Prof. H. S. Gutowsky, research advisor).
- 1981 B.S. Chemistry, University of Texas-Austin, High Honors

Professional Experience

- Cockrell Family Regents Chair
University of Texas at Austin
Sept '07-present
- John Evans Professor of Nanoengineering
Northwestern University
2003 – Aug 2007
- Full Professor, Department of Mechanical Engineering
Director, NU BIMat Center
Northwestern University, IL
2000 - present
- Associate Professor, Department of Physics
Washington University, MO
1997 - 2000
- Research Staff Scientist, Molecular Physics Laboratory
SRI International
1991 – 1996
- Postdoctoral Fellow
IBM-Watson Research Laboratory
1990 – 1991
- Fulbright Postdoctoral Fellow
Max Planck Institut fuer Stroemungsforschung, Goettingen, Germany
1989 - 1990

Professional Associations and Activities

Editor: *Journal of Nanoengineering and Nanosystems*

Managing Editor and Editorial Advisory Board: *NANO*

Associate Editor: *Composites, Science, and Technology*

Scientific Advisory Board, Zyvex

External Advisory Board, Nanonet, State of Oklahoma

Member, American Chemical Society

Member, American Physical Society

Member, Materials Research Society

Member, Electrochemical Society

Member of ASME

Chairman of the Fullerenes Group, Electrochemical Society 1991 – 1998

Co-organized 14 professional society meetings (2 MRS, 1 APS, and 11 ECS)

US organizer of NanoForum CH-US 2003, Swiss-US Forum on Nanoscience and

Nanotechnology with a focus on nanomechanics and Single Molecule Research

US organizer of Inter-Pacific Workshop on Nanoscience and Nanotechnology with a focus

Nano/Bio Interface, Hong Kong, Nov 22-24, 2004.

Awards & Honors

Fulbright Fellow, 1988-89, MPI fuer Stroemungsforschung, Goettingen, Germany

Distinguished Chair Visiting Professor, 2005-current, Sung Kyun Kwan University Advanced
Institute of NanoTechnology (SAINT)

Languages

English, Spanish, German

Citizenship

U.S.

Ruoff Group Current Research Efforts

Major interests are:

- Synthesis and properties of individual nanostructures
- Fabrication and properties of nanocomposites and networked nanostructures
- Global environment and energy
- Nanomanipulation and nanorobotics
- Instrument development and technology transition
- New tools and methods for the biomedical sciences

Ruoff Group Current Members, May, 2007

Research Scientists

Richard Piner

Postdoctoral Fellows

Jin Ho An, Weiwei Cai, Inhwa Jung, Xuesong Li, Sungjin Park, Aruna Velamakanni, Dongxing Yang, Yanwu Zhu.

Graduate Students

Colin Beal, Brad Camburn, Carl Magnuson, Meryl Stoller, Ji-Won Suk. Expecting visiting graduate students from KAIST, Sept '08. Shery Huang (Cambridge University, Summer 2008)

Undergraduate Students

Shailee Mehta (IIT-Bombay, Summer 2008), Jennifer Caraway (Univ of the Incarnate Word, Summer 2008)

Ruoff Group Alumni

		<u>Current Position</u>
Kevin Ausman	Postdoctoral Fellow (1998 – 2000)	Executive Director, Center for Biological & Environmental Nanotechnology Rice University, TX; recently became Asst. Prof. Oklahoma State University, Stillwater, OK
Jaehyun Chung	Ph.D. Student (co-advisor) Postdoctoral Fellow (2004 – 2005)	Asst. Professor, Department of Mechanical Engineering, University of Washington Seattle, WA
Weiqiang Ding	Ph.D. Student & Postdoctoral Fellow (2000 – 2005)	Asst. Professor, Clarkson University Clarkson, NY
Geoffrey Dommett	Ph.D. Student (Physics) (2002-2007)	
Frank Fisher	Postdoctoral Fellow	Asst. Professor, Stevens Institute of

	(2002 – 2004)	Technology, Hoboken, NJ
Hui Huang	Postdoctoral Fellow (1998 – 2000)	BioArray Solutions, Ltd., Warren, NJ
Zebin Huang	Master's Student (2002 – 2004)	LinkQuest, Inc; San Diego, CA
Oleg Lourie	Postdoctoral Fellow (1999 – 2001)	Applications Manager, GATAN Inc. Pleasanton, CA
Shaoning Lu	Ph.D. Student (2000 – 2005)	Touchdown Technology Baldwin Park, CA
Xuekun Lu	Postdoctoral Fellow (1997 – 2000)	Senior Research Associate University of Minnesota
Henry Rohrs	Postdoctoral Fellow (1998 – 2000)	Washington University Staff Scientist, Mass Spec facility
Abel Thangawng	Ph.D. Student (2002-2007)	NRL postdoctoral fellow
Ting (Terry) Xu	Ph.D. Student (2000 – 2005)	Asst. Professor, Dept of Mechanical UNC-Charlotte; Charlotte, NC
Eric Zimney	Master's degree (2003-2006)	Boeing, Seattle, Washington
Min-Feng Yu	Ph.D. Student (1997 – 2000)	Assoc. Professor, Dept. of Mechanical & Industrial Eng., UIUC, Urbana, IL
Sasha Stankovich	Postdoctoral Fellow (2003-2007)	Milliken and Company Spartanburg, South Carolina
Steven Irons	Postdoctoral Fellow (1998-2000)	Yale University Dept of Physics
Inhwa Jung	Ph.D. Student (2004-2008)	Postdoc, Ruoff group

Journal Articles Published

1. G. M. Stewart, M. D. Ensminger, T. J. Kulp, R. S. Ruoff, and J. D. McDonald, *Intramolecular vibrational energy transfer in methyl formate*. J. Chem. Phys., **79**, 3190-200 (1983).

2. G. Stewart, R. Ruoff, T. Kulp, and J. D. McDonald, *Intramolecular vibrational relaxation in dimethyl ether*. J. Chem. Phys., **80**, 5353-8 (1984).
3. T. Kulp, R. Ruoff, G. Stewart, and J. D. McDonald, *Intramolecular vibrational relaxation in 1,4-dioxane*. J. Chem. Phys., **80**, 5359-64 (1984).
4. R. S. Ruoff, T. J. Kulp, and J. D. McDonald, *C-H stretch excitation causes conformational interconversion in ground state methyl vinyl ether but not in methyl nitrite*. J. Chem. Phys., **81**, 4414-20 (1984).
5. T. Kulp, R. S. Ruoff, and J. D. McDonald, *Limits on the lifetimes of intramolecular rovibrational relaxation*. J. Chem. Phys., **82**, 2175-9 (1985).
6. R. S. Ruoff, T. Emilsson, C. Chuang, T. D. Klots, and H. S. Gutowsky, *Experimental separation of torsional and charge redistribution effects in rotational spectra of hydrogen cyanide dimers*. Chem. Phys. Lett., **138**, 553-8 (1987).
7. T. D. Klots, C. Chuang, R. S. Ruoff, T. Emilsson, and H. S. Gutowsky, *Rotational spectra and structures of the argon dimer-hydrogen chloride (Ar₂-H³⁵Cl/³⁷Cl) trimers*. J. Chem. Phys., **86**, 5315-22 (1987).
8. T. D. Klots, R. S. Ruoff, C. Chuang, T. Emilsson, and H. S. Gutowsky, *Rotational spectrum and structure of the argon trimer-hydrogen chloride symmetric top*. J. Chem. Phys., **87**, 4383-7 (1987).
9. R. S. Ruoff, T. I. Emilsson, T. D. Klots, C. Chuang, and H. S. Gutowsky, *Rotational spectra and structures of small clusters containing the hydrogen cyanide dimer: hydrogen cyanide dimer-argon (HCN)₂-Ar, a T-shaped trimer*. J. Chem. Phys., **88**, 1557-63 (1988).
10. H. S. Gutowsky, C. Chuang, T. D. Klots, T. Emilsson, R. S. Ruoff, and K. R. Krause, *Rotational spectra and structures of small clusters: the argon tetramer-hydrogen fluoride (deuterium fluoride)(Ar₄-HF/DF) pentamers*. J. Chem. Phys., **88**, 2919-24 (1988).
11. R. S. Ruoff, T. Emilsson, T. D. Klots, C. Chuang, and H. S. Gutowsky, *Rotational spectrum and structure of the linear hydrogen cyanide trimer*. J. Chem. Phys., **89**, 138-48 (1988).
12. H. L. Kim, T. K. Minton, R. S. Ruoff, T. J. Kulp, and J. D. McDonald, *Rovibrational state mixing in the aldehyde C-H stretch fundamental region of acetaldehyde*. J. Chem. Phys., **89**, 3955-61 (1988).
13. T. D. Klots, T. Emilsson, R. S. Ruoff, and H. S. Gutowsky, *Microwave spectra of noble gas-pyridine dimers: argon-pyridine and krypton-pyridine*. J. Phys. Chem., **93**, 1255-61 (1989).
14. R. S. Ruoff, T. Emilsson, C. Chuang, T. D. Klots, and H. S. Gutowsky, *Rotational spectra and structures of small clusters containing the hydrogen cyanide dimer: (HCN)₂-Y with Y = hydrogen fluoride, hydrogen chloride, trifluoromethane, and carbon dioxide*. J. Chem. Phys., **90**, 4069-78 (1989).
15. T. D. Klots, R. S. Ruoff, and H. S. Gutowsky, *Rotational spectrum and structure of the linear carbon dioxide-hydrogen cyanide dimer: dependence of isomer formation on carrier gas*. J. Chem. Phys., **90**, 4216-21 (1989).
16. R. S. Ruoff, T. Emilsson, C. Chuang, T. D. Klots, and H. S. Gutowsky, *Rotational spectra and structures of small clusters containing the hydrogen cyanide dimer: X-(HCN)₂ with X = carbon monoxide, molecular nitrogen, ammonia, and water*. J. Chem. Phys., **93**, 6363-70 (1990).
17. H. S. Gutowsky, J. Chen, P. J. Hajduk, and R. S. Ruoff, *Rotational spectrum and structure of the hydrogen cyanide-carbon dioxide (CO₂)₂ trimer*. J. Phys. Chem., **94**, 7774-80 (1990).
18. H. S. Gutowsky, P. J. Hajduk, C. Chuang, and R. S. Ruoff, *Rotational spectrum and structure of the hydrogen cyanide-(carbon dioxide trimer) (HCN-(CO₂)₃) tetramer*. J. Chem. Phys., **92**, 862-9 (1990).
19. R. S. Ruoff, T. D. Klots, T. Emilsson, and H. S. Gutowsky, *Relaxation of conformers and isomers in seeded supersonic jets of inert gases*. J. Chem. Phys., **93**, 3142-50 (1990).
20. T. Emilsson, T. D. Klots, R. S. Ruoff, and H. S. Gutowsky, *Rotational spectra and structures of the carbon monoxide- and ammonia-hydrogen cyanide-hydrogen fluoride trimers: coaxial mixing nozzle for reactive species*. J. Chem. Phys., **93**, 6971-6 (1990).
21. R. S. Ruoff, *Mutual polarization of monomer charge distribution in hydrogen cyanide dimer, trimer, and infinite chain ((HCN)₂, (HCN)₃, and (HCN)_n)*. J. Chem. Phys., **94**, 2717-22 (1991).
22. R. S. Ruoff and A. L. Ruoff, *Is C₆₀ stiffer than diamond*. Nature, **350**, 663 (1991).

23. R. S. Ruoff, D. Beach, J. Cuomo, T. McGuire, R. L. Whetten, and F. Diederich, *Confirmation of a vanishingly small ring-current magnetic susceptibility of icosahedral buckminsterfullerene*. J. Phys. Chem., **95**, 3457-9 (1991).
24. R. S. Ruoff, T. Thornton, and D. Smith, *Density of fullerene-containing soot as determined by helium pycnometry*. Chem. Phys. Lett., **186**, 456-8 (1991).
25. R. S. Ruoff and A. L. Ruoff, *The bulk modulus of buckminsterfullerene molecules and crystals: a molecular mechanics approach*. Appl. Phys. Lett., **59**, 1553-5 (1991).
26. C. Chuang, T. D. Klots, R. S. Ruoff, T. Emilsson, and H. S. Gutowsky, *Tunneling in a linear diborane (6)-hydrogen chloride (B₂H₆-HCl) dimer*. J. Chem. Phys., **95**, 1552-62 (1991).
27. R. S. Ruoff, T. Emilsson, A. I. Jaman, T. C. Germann, and H. S. Gutowsky, *Rotational spectra, dipole moment, and structure of the tetrafluorosilane-ammonia dimer*. J. Chem. Phys., **96**, 3441-6 (1992).
28. C. Smart, B. Eldridge, W. Reuter, J. A. Zimmerman, W. R. Creasy, N. Rivera, and R. S. Ruoff, *Extraction of giant fullerene molecules, and their subsequent solvation in low boiling point solvents*. Chem. Phys. Lett., **188**, 171-6 (1992).
29. P. Hvelplund, L. H. Andersen, H. K. Haugen, J. Lindhard, D. C. Lorents, R. Malhotra, and R. Ruoff, *Dynamical fragmentation of C₆₀ fullerene ions*. Phys. Rev. Lett., **69**, 1915-18 (1992).
30. W. Krakow, N. M. Rivera, R. A. Roy, R. S. Ruoff, and J. J. Cuomo, *Epitaxial growth of C₆₀ thin films on mica*. J. Mater. Res., **7**, 784-7 (1992).
31. W. R. Creasy, J. A. Zimmerman, and R. S. Ruoff, *Fullerene molecular weight distributions in graphite soot extractions measured by laser desorption Fourier transform mass spectrometry*. J. Phys. Chem., **97**, 973-9 (1993).
32. L. Moro, R. S. Ruoff, C. H. Becker, D. C. Lorents, and R. Malhotra, *Studies of metallofullerene primary soots by laser and thermal desorption mass spectrometry*. J. Phys. Chem., **97**, 6801-5 (1993).
33. W. Krakow, N. M. Rivera, R. A. Roy, R. S. Ruoff, and J. J. Cuomo, *The growth of crystalline vapor deposited carbon-60 thin films*. Appl. Phys. A, **A56**, 185-92 (1993).
34. R. Malhotra, D. F. McMillen, D. S. Tse, D. C. Lorents, R. S. Ruoff, and D. M. Keegan, *Hydrogen-transfer reactions catalyzed by fullerenes*. Energy Fuels, **7**, 685-6 (1993).
35. R. S. Ruoff, D. C. Lorents, B. Chan, R. Malhotra, and S. Subramoney, *Single crystal metals encapsulated in carbon nanoparticles*. Science, **259**, 346-8 (1993).
36. R. S. Ruoff and A. P. Hickman, *Van der Waals binding to fullerenes to a graphite plane*. J. Phys. Chem., **97**, 2494-6 (1993).
37. R. S. Ruoff, Y. Wang, and D. Tomanek, *Lanthanide- and actinide-based fulleride compounds: potential A_xC₆₀ superconductors?* Chem. Phys. Lett., **203**, 438-43 (1993).
38. R. S. Ruoff, J. Tersoff, D. C. Lorents, S. Subramoney, and B. Chan, *Radial deformation of carbon nanotubes by van der Waals forces*. Nature, **364**, 514-16 (1993).
39. R. S. Ruoff, *Prediction of enthalpies of sublimation of fullerenes from first-order molecular connectivity theory*. Chem. Phys. Lett., **208**, 256-8 (1993).
40. R. S. Ruoff, D. S. Tse, R. Malhotra, and D. C. Lorents, *Solubility of fullerene (C₆₀) in a variety of solvents*. J. Phys. Chem., **97**, 3379-83 (1993).
41. R. S. Ruoff, R. Malhotra, D. L. Huestis, D. S. Tse, and D. C. Lorents, *Anomalous solubility behavior of fullerene C₆₀*. Nature, **362**, 140-1 (1993).
42. Y. Wang, D. Tomanek, and R. S. Ruoff, *Stability of M@C₆₀ endohedral complexes*. Chem. Phys. Lett., **208**, 79-85 (1993).
43. N. H. Tea, R. C. Yu, M. B. Salamon, D. C. Lorents, R. Malhotra, and R. S. Ruoff, *Thermal conductivity of fullerenes (C₆₀ and C₇₀) crystals*. Appl. Phys. A, **A56**, 219-25 (1993).
44. H. Yamawaki, M. Yoshida, Y. Kakudate, S. Usuba, H. Yokoi, S. Fujiwara, K. Aoki, R. Ruoff, R. Malhotra, and D. Lorents, *Infrared study of vibrational property and polymerization of fullerene C₆₀ and C₇₀ under pressure*. J. Phys. Chem., **97**, 11161-3 (1993).
45. Y. Wang, D. Tomanek, G. F. Bertsch, and R. S. Ruoff, *Stability of C₆₀ fullerite intercalation compounds*. Phys. Rev. B: Condens. Matter, **47**, 6711-20 (1993).
46. D. Tomanek, Y. Wang, and R. S. Ruoff, *Stability of fullerene-based systems*. J. Phys. Chem. Solids, **54**, 1679-84 (1993).
47. J. Tersoff and R. S. Ruoff, *Structural properties of a carbon-nanotube crystal*. Phys. Rev. Lett., **73**, 676-9 (1994).

48. R. S. Ruoff, D. S. Tse, R. Malhotra, D. C. Lorents, and D. L. Huestis, *Solubility properties of C₆₀*. Trans. Mater. Res. Soc. Jpn., **14B**, 1193-6 (1994).
49. D. C. Lorents, R. S. Ruoff, R. Malhotra, and S. Subramoney, *Giant nested fullerenes: morphology and metal encapsulation*. Mol. Cryst. Liq. Cryst. Sci. Technol., Sect. C, **4**, 15-22 (1994).
50. R. S. Ruoff, D. C. Lorents, B. Chan, R. Malhotra, and S. Subramoney, *Single crystal metals encapsulated in carbon nanoparticles*. Trans. Mater. Res. Soc. Jpn., **16B**, 1589-91 (1994).
51. W. Luo, H. Wang, R. S. Ruoff, J. Cioslowski, and S. Phelps, *Susceptibility discontinuity in single crystal C₆₀*. Phys. Rev. Lett., **73**, 186-8 (1994).
52. R. Malhotra, A. Satyam, S. Kumar, S. C. Narang, D. S. Tse, R. S. Ruoff, and D. C. Lorents, *Approaches to chemical functionalization of fullerenes*. Trans. Mater. Res. Soc. Jpn., **14B**, 1177-9 (1994).
53. P. Hvelplund, L. H. Andersen, C. Brink, D. H. Yu, D. C. Lorents, and R. Ruoff, *Charge transfer in collisions involving multiply charged C₆₀ molecules*. Z. Phys. D: At, Mol. Clusters, **30**, 323-6 (1994).
54. S. Subramoney, R. S. Ruoff, D. C. Lorents, B. Chan, R. Malhotra, M. J. Dyer, and K. Parvin, *Magnetic separation of GdC₂ encapsulated in carbon nanoparticles*. Carbon, **32**, 507-13 (1994).
55. P. Boulas, M. T. Jones, K. M. Kadish, R. S. Ruoff, D. C. Lorents, and D. S. Tse, *ESR Characterization of Singly-, Doubly-, and Triply-Reduced C₈₄ Isomers*. J. Am. Chem. Soc., **116**, 9393-4 (1994).
56. R. S. Ruoff, *Carbon nanotubes. The continuing saga*. Nature, **372**, 731-2 (1994).
57. D. H. Yu, L. H. Andersen, C. Brink, P. Hvelplund, D. C. Lorents, and R. Ruoff, *Formation and destruction of fullerene anions*. Mol. Cryst. Liq. Cryst. Sci. Technol., Sect. C, **4**, 237-40 (1994).
58. G. B. Adams, M. O'Keeffe, and R. S. Ruoff, *Van Der Waals Surface Areas and Volumes of Fullerenes*. J. Phys. Chem., **98**, 9465-9 (1994).
59. G. Sauve, P. V. Kamat, and R. S. Ruoff, *Excited Triplet and Reduced Forms of C₈₄*. J. Phys. Chem., **99**, 2162-5 (1995).
60. R. S. Ruoff and D. C. Lorents, *Mechanical and thermal properties of carbon nanotubes*. Carbon, **33**, 925-30 (1995).
61. R. S. Ruoff, K. M. Kadish, P. Boulas, and E. C. M. Chen, *Relationship between the Electron Affinities and Half-Wave Reduction Potentials of Fullerenes, Aromatic Hydrocarbons, and Metal Complexes*. J. Phys. Chem., **99**, 8843-50 (1995).
62. M. Moalem, M. Balooch, A. V. Hamza, and R. S. Ruoff, *Sublimation of Higher Fullerenes and Their Interaction with Silicon (100) Surface*. J. Phys. Chem., **99**, 16736-41 (1995).
63. R. Malhotra, R. S. Ruoff, and D. C. Lorents, *Fullerene materials*. Adv. Mater. Processes, **147**, 29-32 (1995).
64. L. S. Fomenko, V. D. Natsik, S. V. Lubenets, V. G. Lirtsman, N. V. Akenova, A. P. Isakina, A. I. Prokhvatilov, M. A. Strezhemechny, and R. S. Ruoff, *Correlations of low-temperature microplasticity anomalies with structural transformations in C₆₀ crystals*. Fiz. Nizk. Temp., **21(4)**, 465-8 (1995).
65. K. Tohji, A. Paul, L. Moro, R. Malhotra, D. C. Lorents, and R. S. Ruoff, *Selective and High-Yield Synthesis of Higher Fullerenes*. J. Phys. Chem., **99**, 17785-8 (1995).
66. W. Rivera, J. M. Perez, R. S. Ruoff, D. C. Lorents, R. Malhotra, S. Lim, Y. G. Rho, E. G. Jacobs, and R. F. Pinizzotto, *Scanning tunneling microscopy current-voltage characteristics of carbon nanotubes*. J. Vac. Sci. Technol., B, **13**, 327-30 (1995).
67. L. F. Allard, E. Voelkl, A. Carim, A. K. Datye, and R. Ruoff, *Morphology and crystallography of nanoparticulates revealed by electron holography*. Nanostruct. Mater., **7**, 137-46 (1996).
68. M. V. Korobov, A. L. Mirak'yan, N. V. Avramenko, and R. Ruoff, *Abnormal temperature dependence of solubility of C₆₀*. Dokl. Akad. Nauk, **349**, 346-349 (1996).
69. R. S. Ruoff, *(NH₄)₃C₆₀: A New C₆₀ Superconductor?* J. Phys. Chem., **100**, 8973-6 (1996).
70. P. L. Boulas, M. T. Jones, R. S. Ruoff, D. C. Lorents, R. Malhotra, D. S. Tse, and K. M. Kadish, *Electrochemical and ESR Characterization of C₈₄ and Its Anions in Aprotic Solvents*. J. Phys. Chem., **100**, 7573-9 (1996).

71. S. V. Lubenets, V. D. Natsik, L. S. Fomenko, A. P. Isakina, A. I. Prokhvatilov, M. A. Strzhemechny, and N. A. Aksenova, *The structure, slip systems, and microhardness of C₆₀ crystals*. Low Temperature Physics, **23**, 251-261 (1997).
72. L. Moro, A. Paul, D. C. Lorents, R. Malhotra, R. S. Ruoff, P. Lazzeri, L. Vanzetti, A. Lui, and S. Subramoney, *Silicon carbide formation by annealing C₆₀ films on silicon*. J. Appl. Phys., **81**, 6141-6146 (1997).
73. L. Moro, A. Paul, D. C. Lorents, R. Malhotra, R. S. Ruoff, and L. Jiang, *Patterning silicon carbide on silicon by ion modification of C₆₀ films*. Nucl. Instrum. Methods Phys. Res., Sect. B, **121**, 151-153 (1997).
74. L. Moro, A. Paul, D. C. Lorents, R. Malhotra, R. S. Ruoff, L. Jiang, G. W. Stupian, W. K. Wu, and S. Subramoney, *Growth of patterned SiC by ion modification and annealing of C₆₀ films on silicon*. Applied Surface Science, **119**, 76-82 (1997).
75. M. V. Korobov, A. L. Mirakian, N. V. Avramenko, E. F. Valeev, I. S. Neretin, Y. L. Slovokhotov, A. L. Smith, G. Olofsson and R. S. Ruoff, *C₆₀ bromobenzene solvate: Crystallographic and thermochemical studies and their relationship to C₆₀ solubility in bromobenzene*. J. Phys. Chem. B, **102**, 3712-3717 (1998).
76. G. Che, B. B. Lakshmi, C. R. Martin, E. R. Fisher and R. S. Ruoff, *Chemical vapor deposition based synthesis of carbon nanotubes and nanofibers using a template method*. Chemistry of Materials, **10**, 260-267 (1998).
77. M. F. Yu, M. J. Dyer, H. W. Rohrs, X. K. Lu, K. D. Ausman, J. V. Ehr and R. S. Ruoff, *Manipulation of Carbon Nanotubes Using Scanning Probe Microscopes*, Nanotechnology, **10**, 244-252 (1999).
78. M. V. Korobov, A. L. Mirakyan, N. V. Avramenko, G. Olofsson, A. L. Smith and R. S. Ruoff, *Calorimetric studies of solvates of C-60 and C-70 with aromatic solvents*, J. Phys. Chem., B, **103**, 1339-1346 (1999).
79. D. Srivastava, D. W. Brenner, J. D. Schall, K. D. Ausman, M. F. Yu and R. S. Ruoff, *Predictions of enhanced chemical reactivity at regions of local conformational strain on carbon nanotubes: Kinky chemistry*, J. Phys. Chem., B, **103**, 4330-4337 (1999).
80. X. K. Lu, K. D. Ausman, R. D. Piner and R. S. Ruoff, *Scanning electron microscopy study of carbon nanotubes heated at high temperatures in air*, J. Appl. Phys., **86**, 186-189 (1999).
81. X. K. Lu, H. Huang, N. Nemchuk and R. S. Ruoff, *Patterning of highly oriented pyrolytic graphite by oxygen plasma etching*, Appl. Phys. Lett., **75**, 193-195 (1999).
82. X. K. Lu, M. F. Yu, H. Huang and R. S. Ruoff, *Tailoring graphite with the goal of achieving single sheets*, Nanotechnology, **10**, 269-272 (1999).
83. K. D. Ausman, H. W. Rohrs, M. F. Yu and R. S. Ruoff, *Nanostressing and mechanochemistry*, Nanotechnology, **10**, 258-262 (1999).
84. M. F. Yu, M. J. Dyer, G. D. Skidmore, H. W. Rohrs, X. K. Lu, K. D. Ausman, J. R. Von Ehr and R. S. Ruoff, *Three-dimensional manipulation of carbon nanotubes under a scanning electron microscope*, Nanotechnology, **10** 244-252 (1999).
85. M. F. Yu, O. Lourie, M. J. Dyer, K. Moloni, T. F. Kelly and R. S. Ruoff, *Strength and breaking mechanism of multiwalled carbon nanotubes under tensile load*, Science, **287**, 637-640 (2000).
86. M. F. Yu, B. S. Files, S. Arepalli and R. S. Ruoff, *Tensile loading of ropes of single wall carbon nanotubes and their mechanical properties*, Phys. Rev. Lett., **84**, 5552-5555 (2000).
87. O. Lourie, C. R. Jones, B. M. Bartlett, P. C. Gibbons, R. S. Ruoff and W. E. Buhro, *CVD growth of boron nitride nanotubes*, Chemistry of Materials, **12**, 1808-1810 (2000).
88. M. F. Yu, T. Kowalewski and R. S. Ruoff, *Investigation of the radial deformability of individual carbon nanotubes under controlled indentation force*, Phys. Rev. Lett., **85**, 1456-1459 (2000).
89. B. Faircloth, H. Rohrs, R. Tiberio, R. S. Ruoff and R. R. Krchnavek, *Bilayer, nanoimprint lithography*, J. Vac. Sci. Technol., B, **18**, 1866-1873 (2000).
90. M. F. Yu, B. I. Yakobson and R. S. Ruoff, *Controlled sliding and pullout of nested shells in individual multiwalled carbon nanotubes*, J. Phys. Chem., B, **104**, 8764-8767 (2000).
91. K. D. Ausman, R. Piner, O. Lourie, R. S. Ruoff and M. Korobov, *Organic solvent dispersions of single-walled carbon nanotubes: Toward solutions of pristine nanotubes*, J. Phys. Chem., B, **104**, 8911-8915 (2000).

92. M. F. Yu, T. Kowalewski and R. S. Ruoff, *Structural analysis of collapsed, and twisted and collapsed, multiwalled carbon nanotubes by atomic force microscopy*, Phys. Rev. Lett., **86**, 87-90 (2001).
93. M. F. Yu, M. J. Dyer and R. S. Ruoff, *Structure and mechanical flexibility of carbon nanotube ribbons: An atomic-force microscopy study*, J. Appl. Phys., **89**, 4554-4557 (2001).
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Patents

1. R. S. Ruoff, D. C. Lorents, R. Malhotra, M. J. Dyer *et al.*, *Carbon nanoencapsulates*, US 5547748 serial number 182283
2. W. Eidelloth, J. T. Busch, R. J. Gambino, R. Ruoff, C. D. Tesche, *Superconducting thin film with fullerenes and method of making*, US 5332723 serial number 098094
3. W. Eidelloth, J. T. Busch, R. J. Gambino, R. Ruoff, C. D. Tesche, *Method of making high Tc superconducting thin films with fullerenes by evaporation*, US 5356872 serial number 215778
4. R. S. Ruoff, *Street and ice hockey stick*, US 5685792 serial number 561912
5. R. S. Ruoff, *Designer Particles of Micron and sub-Micron dimension*, US 6284345 September 4 2001 (Date of patent)

Invited Presentations

A short list of many invited presentations is provided here:

- Annual meetings of the ACS, MRS, APS, ECS, American Society of Composites (ASC), Society of Experimental Mechanics (SEM), ASME, Society of Experimental Science (SES), AVS, Advanced Coating Symposium of TAPPI
- Invitations to the National Academy of Sciences (NAS); National Science Foundation; NASA Research Centers - Ames, Langley, Johnson, Marshall and Glenn; DOE Labs - Argonne, ORNL, LBL; workshops sponsored by ARO; Naval Research Laboratory; and the Air Force Research Laboratory
- Invitations to a large number of universities, including (among others) in the United States: Auburn, Arizona, ASU, Cal Tech, UCSB, UCLA, UC-Berkeley, UC-Boulder, San Jose State, Stanford, Connecticut, Delaware, UIUC, Illinois-Chicago, Chicago, Northwestern, Purdue, Kansas State, Kentucky, Louisville, Harvard, Michigan, Washington U. - St. Louis, Cornell,

Rochester, Brown, Rutgers, Princeton, North Carolina -Chapel Hill, North Carolina State, Ohio State, Dayton, Case Western, Oklahoma, Oklahoma State, Pennsylvania, Carnegie Mellon, South Carolina, Texas-Austin, Rice, Wisconsin-Madison.

- Invited lectures abroad include: Switzerland: Univ. of Basel, Univ. of Fribourg, EPFL, ETH Zurich; Japan: U. Tokyo, Mie University, Nagoya University, Tokyo Metropolitan University, NIMC (a national lab located in Tsukuba, Japan); Mexico: UNAM (Mexico City), Univ. of Queretaro (Queretaro, Mexico); Colombia: Univ. de los Andes and National University (Bogota), Univ. del Valle (Cali), Univ de Antioquia (Medellin); Canada: Univ. of Toronto; Hong Kong: City University of Hong Kong and HKUST; Italy: Univ. of Perugia; Russia: Moscow State University; South Korea: Seoul National University, KAIST; Greece: National University in Athens. Turkey: Bogacizi, Koc, ITU, Sabanci Universities, all in Istanbul, conferences held in Hong Kong, Basel, Paris, Tokyo, Berlin, Sussex, Perugia, Cancun, Buenos Aires, Toronto, Montreal, Quebec City, St. Petersburg.
- Invitations to industrial research labs: IBM Watson, IBM Almaden, Zyvex, DuPont, Dow Chemical (Midland, MI), Cabot Microelectronics, Inc., UOP LLC., Gas Technology Institute
- Invitations to a number of trade or not-for-profit organizations such as the Chicago Micro Nano Community, the high-tech club of the Union Club of Chicago and others.

Current and Recent Teaching Activities

At Northwestern University:

Nanotechnology (ME 385)

Manipulation of matter at the nanometer length scale to produce useful devices and materials; nanoscale sensors; mechanical & electrical systems; molecular electronics for memory and computing; novel materials; scientific and engineering properties of nanoscale systems.

Selected Topics in Nanotechnology (ME 495)

Studies on several topics related to nanotechnology; similar in format to ME 385 but at level appropriate for graduate students

Nanotechnology: Manufacturing and Business Opportunities (ME 497)

This course assesses opportunities in manufacturing and in business related to the emerging field of nanotechnology. Invited speakers from the business community present their perspective on business opportunities & challenges presented by nanotechnology and also some of the manufacturing issues faced.

Experimental Engineering (ME224)

This course covers instrumentation and the use of experiments to evaluate real-world systems. Basic, practical electronics, computer data acquisition, programming and signal conditioning are taught and then applied in experiments that investigate heat transfer, fluids mechanics, thermodynamics and structural dynamics.

Thermodynamics I (ME220)

The objective of the science of thermodynamics is to describe the state of matter and its interactions with surroundings in terms of macroscopic properties such as temperature, pressure, etc. The course will introduce the fundamentals of the science of classical thermodynamics. Historical perspectives on the evolution of this field and its gradual development into a modern branch of science will be presented. The applications of the First and the Second Laws of thermodynamics to the analysis of performance and efficiency of pumps, compressors, turbines, nozzles, diffusers, and other engineering systems will be discussed.

At UT Austin:

Nanoscale Science and Technology (ME397)

Manipulation of matter at the nanometer length scale to produce useful devices and materials; nanoscale sensors; mechanical & electrical systems; molecular electronics for memory and computing; novel materials; scientific and engineering properties of nanoscale systems.