

Charles M. Lieber
Department of Chemistry and Chemical Biology
Harvard John A. Paulson School of Engineering and Applied Sciences
Harvard University
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Personal Data

Date and Place of Birth: 9 April 1959; Philadelphia, PA

Academic Training

Undergraduate: B.A. in Chemistry, Franklin and Marshall College, 1981

Graduate: Ph.D. in Chemistry, Stanford University, 1985

Postgraduate: Postdoctoral Research, California Institute of Technology, 1985-1987

Professional Experience

1987-1990: Assistant Professor of Chemistry, Columbia University

1990-1991: Associate Professor of Chemistry, Columbia University

1991-1999: Professor of Chemistry, Harvard University

1999-present: Mark Hyman Professor of Chemistry, Harvard University

2015-present: Chair, Department of Chemistry and Chemical Biology, Harvard University

Academic and Professional Awards

MRS Von Hippel Award (2016); Remsen Award (2016); Nano Research Award, Tsinghua University Press/Springer (2013); IEEE Nanotechnology Pioneer Award (2013); Willard Gibbs Medal (2013); Wolf Prize in Chemistry (2012); Fred Kavli Distinguished Lectureship in Nanoscience, Materials Research Society (2010); Friendship Award, People's Republic of China (2009); Inorganic Nanoscience Award, ACS Division of Inorganic Chemistry (2009); Pioneer Award, National Institutes of Health (2008); Einstein Award, Chinese Academy of Sciences (2008); NBIC Research Excellence Award, University of Pennsylvania (2007); Nanotech Briefs Nano 50 Award (2005); World Technology Award in Materials (2004); ACS Award in the Chemistry of Materials (2004); Scientific American 50 Award in Nanotechnology and Molecular Electronics (2003); Nelson W. Taylor Award, Pennsylvania State University (2003); World Technology Award in Materials (2003); New York Intellectual Property Law Association Inventor of the Year Award (2003); APS McGroddy Prize for New Materials (2003); Harrison Howe Award, University of Rochester (2002); MRS Medal (2002); Foresight Institute Feynman Prize in Nanotechnology (2001); NSF Creativity Award (1996); Leo Hendrik Baekeland Award, American Chemical Society (1995); George Ledlie Prize, Harvard University (1994-1995); MRS Outstanding Young Investigator Award (1993); ACS Award in Pure Chemistry (1992); Denkwalter Prize, Loyola University Chicago (1992); Camille and Henry Dreyfus Teacher-Scholar Award (1990-1995); Alfred P. Sloan Research Fellowship (1990-1992); Wilson Prize (1990); NSF Presidential Young Investigator Award (1988-1993); David and Lucile Packard Fellowship (1988-1993); Distinguished New Faculty Award, Dreyfus Foundation (1987); NIH Postdoctoral Research Fellow (1985-1987); Joseph W. Richards Fellow of the Electrochemical Society (1985); American Institute of Chemists Distinguished Senior Award (1981); Theodore Saulnier Research Award (1981); Pentathlon Medal for Excellence in Chemistry (1981).

Elected Memberships and Fellowships

Elected Foreign Member, Chinese Academy of Science (2015); Elected Member, National Academy of Inventors (2013); Fellow, American Chemical Society, Inaugural Class (2009); Honorary Fellow, Chinese Chemical Society (2009); Elected Fellow, Materials Research Society (2008); Elected Fellow, Institute of Physics (2004); Elected Member, National Academy of Sciences (2004); Elected Fellow, American Academy of Arts and Sciences (2002); Elected Fellow, World Technology Network (2002); Elected Fellow, International Union of Pure and Applied Chemistry (2000); Elected Fellow, American Association for the Advancement of Science (1996); Elected Fellow, American Physical Society (1996).

Honorary Professorships

Nankai University (2014); Institute of Chemistry, Chinese Academy of Sciences (2014); University of Science and Technology Beijing (2011); Peking University (2008); Tsinghua University (2002); University of Science and Technology of China (2002); Fudan University (2002); Zhejiang University (2002).

Professional Society Memberships

American Association for the Advancement of Science, American Chemical Society, American Physical Society, Institute of Electrical and Electronics Engineers, International Society for Optical Engineering, Materials Research Society, Optical Society of America, Society for Neuroscience.

Scientific Advisory Boards

International Academic Advisory Committee, Hefei National Laboratory for Physical Sciences at the Microscale, China; Advisory Board, Indian Association of Nanoscience and Nanotechnology; International Advisory Board, National Center for Nanoscience and Technology, China; International Advisory Board, Department of Materials Science and Engineering, Tel-Aviv University; International Board, Weizmann Institute of Science; Scientific and Academic Advisory Committee, Weizmann Institute of Science.

Editorial Advisory Boards

Nano Letters (Co-Editor); Acta Physico-Chimica Sinica (APCS); Chinese Journal of Chemistry; Current Physical Chemistry; Engineering; Frontier of Neuroscience, Neural Nanotechnology section; Hybrid Materials; International Journal of Biomedical Nanoscience and Nanotechnology, Molecular Diagnostics Section; Journal of Advanced Microscopy Research; Journal of Computational and Theoretical Nanoscience; Journal of Nanoscience and Nanotechnology; Nano Energy; Nano Research; Nano Today; Nanoscience and Nanotechnology-Asia.

Research Interests

Chemistry and physics of materials with an emphasis on nanoscale wires for electronics and bioelectronics; rational synthesis and hierarchical assembly of nanowire materials into complex and functional electronic systems; investigation of fundamental electronic, optical and optoelectronic properties of nanoscale materials for advanced digital and quantum electronics; nanoelectronic-biology interfaces with emphasis on real-time, ultra-sensitive biodetectors, new tools for neuroscience and cell biology, and paradigm-shifting nanoelectronic interfaces to tissue and organs with an emphasis on the brain and peripheral nervous system.

Publications

Lieber has published over 380 articles in peer-reviewed scientific journals. His original work has had a defining influence on the field of nanoscience and nanotechnology, where his publications have been cited overall more than 92,300 times, his top 10 papers have been cited more than 26,500 times, and his h-index (impact factor) is 134. Based on his citation impact scores, Lieber was ranked #1 in Chemistry for the decade 2000-2010 by Thomson Reuters. Publications are as follows:

1. C.M. Lieber, C.M. Gronet and N.S. Lewis, "Evidence against surface state limitations on efficiency of p-Si/CH₃CN junctions," *Nature* **307**, 533-534 (1984).
2. M.L. Rosenbluth, C.M. Lieber and N.S. Lewis, "630-mV open circuit voltage, 12% efficient n-Si liquid junction," *Appl. Phys. Lett.* **45**, 423-425 (1984).
3. C.M. Lieber and N.S. Lewis, "Catalytic reduction of CO₂ at carbon electrodes modified with cobalt phthalocyanine," *J. Am. Chem. Soc.* **106**, 5033-5034 (1984).
4. N.S. Lewis, R. Domingues, C.M. Gronet, C.M. Lieber, M.D. Rosenblum, G.W. Cogan, J.F. Gibbons and G.R. Moddel, "Design of efficient semiconductor/liquid junction interfaces in nonaqueous solvents," *Proceedings of the Symposium on the Chemistry and Physics of Electrocatalysis* (eds. J.D.E. McIntyre et al., Electrochemical Society, 1984).
5. C.M. Lieber and N.S. Lewis, "Probing polymer effects on chemical reactivity: Ligand substitution kinetics of Ru(NH₃)₅(H₂O)²⁺ in Nafion films," *J. Am. Chem. Soc.* **107**, 7190-7191 (1985).
6. C.M. Lieber, M.H. Schmidt and N.S. Lewis, "Reaction entropy measurements for transition-metal ions bound to Nafion-coated electrode surfaces," *J. Phys. Chem.* **90**, 1002-1003 (1986).
7. C.M. Lieber, M.H. Schmidt and N.S. Lewis, "Kinetic studies of ligand substitution rates for the Ru(NH₃)₅(H₂O)²⁺ ion in Nafion films," *J. Am. Chem. Soc.* **108**, 6103-6108 (1986).
8. C.M. Lieber, "Probing polymer induced reactivity effects in modified electrode catalyst systems," *J. Electrochem. Soc.* **133**, 442C-444C (1986).
9. C.M. Lieber, J.L. Karas and H.B. Gray, "Reversible long-range electron transfer in ruthenium-modified sperm whale myoglobin," *J. Am. Chem. Soc.* **109**, 3778-3779 (1987).
10. J.L. Karas, C.M. Lieber and H.B. Gray, "Free energy dependence of the rate of long-range electron transfer in proteins. Reorganization energy in ruthenium-modified myoglobin," *J. Am. Chem. Soc.* **110**, 599-600 (1988).
11. C.M. Lieber, J.L. Karas, S.L. Mayo, A.W. Axup, M. Albin, R.J. Crutchley, W.R. Ellis and H.B. Gray, "Long-range electron transfer in ruthenium-modified metalloproteins," *Trace Elements in Man and Animals 6* (eds. L.S. Hurley et al., Plenum Press, 1988).
12. C.M. Lieber, J.L. Karas, S.L. Mayo, M. Albin and H.B. Gray, "Long-range electron transfer in proteins," *Proceedings of the Robert A. Welch Foundation Conference on Chemical Research XXXI*, 9-26 (Welch Foundation, 1988).

13. X.-L. Wu and C.M. Lieber, "Determination of the structural and the electronic properties of surfaces using scanning tunneling microscopy coupled with chemical modifications," *J. Am. Chem. Soc.* **110**, 5200-5201 (1988).
14. X.L. Wu, P. Zhou and C.M. Lieber, "Surface electronic properties probed with tunneling microscopy and chemical doping," *Nature* **335**, 55-57 (1988).
15. X.-L. Wu and C.M. Lieber, "In situ imaging of a detergent monolayer using scanning tunneling microscopy," *J. Phys. Chem.* **92**, 5556-5557 (1988).
16. X.-L. Wu, P. Zhou and C.M. Lieber, "Determination of the local effect of impurities on the charge-density-wave phase in TaS₂ by scanning tunneling microscopy," *Phys. Rev. Lett.* **61**, 2604-2607 (1988).
17. X.L. Wu and C.M. Lieber, "Hexagonal domain-like charge density wave phase of TaS₂ determined by scanning tunneling microscopy," *Science* **243**, 1703-1705 (1989).
18. X.L. Wu and C.M. Lieber, "Scanning tunneling microscopy investigations of a new charge density wave phase in niobium-doped tantalum disulfide," *J. Am. Chem. Soc.* **111**, 2731-2733 (1989).
19. S.P. Kelty and C.M. Lieber, "Scanning tunneling microscopy investigations of the electronic structure of potassium-graphite intercalation compounds," *J. Phys. Chem.* **93**, 5983-5985 (1989).
20. S.P. Kelty and C.M. Lieber, "Atomic-resolution scanning-tunneling-microscopy investigations of alkali-metal-graphite intercalation compounds," *Phys. Rev. B* **40**, 5856-5859 (1989).
21. Y. Kim and C.M. Lieber, "Synthesis and characterization of new binuclear electron-transfer models containing rigid aromatic spacers," *Inorg. Chem.* **28**, 3990-3992 (1989).
22. X.L. Wu, C.M. Lieber, D.S. Ginley and R.J. Baughman, "Scanning tunneling microscopy investigations of the local structure of Tl₂Ba₂CaCu₂O₈ single crystals," *Appl. Phys. Lett.* **55**, 2129-2131 (1989).
23. X.L. Wu and C.M. Lieber, "Direct characterization of charge-density-wave defects in titanium-doped TaSe₂ by scanning tunneling microscopy," *Phys. Rev. B* **41**, 1239-1242 (1990).
24. X.L. Wu and C.M. Lieber, "Direct observation of growth and melting of the hexagonal-domain charge-density-wave phase in 1T-TaS₂ by scanning tunneling microscopy," *Phys. Rev. Lett.* **64**, 1150-1153 (1990).
25. H. Chen, X.L. Wu and C.M. Lieber, "Scanning tunneling microscopy investigations of the local electronic and structural effects of iron substitution in tantalum disulfide," *J. Am. Chem. Soc.* **112**, 3326-3332 (1990).
26. X.L. Wu, Z. Zhang, Y.L. Wang and C.M. Lieber, "Structural and electronic role of lead in (PbBi)₂ Sr₂CaCu₂O₈ superconductors by STM," *Science* **248**, 1211-1214 (1990).

27. Z. Zhang, Y.L. Wang, X.L. Wu, J.-L. Huang and C.M. Lieber, "Electronic effect of lead substitution in single-crystal Bi(Pb)-Sr-Ca-Cu-O superconductors determined by scanning tunneling microscopy," *Phys. Rev. B* **42**, 1082-1085 (1990).
28. Y.L. Wang, X.L. Wu, C.C. Chen and C.M. Lieber, "Enhancement of the critical current density in single-crystal Bi₂Sr₂CaCu₂O₈ superconductors by chemically induced disorder," *Proc. Natl. Acad. Sci. USA* **87**, 7058-7060 (1990).
29. Y. Kim and C.M. Lieber, "Chemically etched silicon surfaces viewed at the atomic level by force microscopy," *J. Am. Chem. Soc.* **113**, 2333-2335 (1991).
30. X.L. Wu, Y.L. Wang, Z. Zhang and C.M. Lieber, "Electronic and structural effects of oxygen doping in Bi₂Sr₂CaCu₂O_x superconductors characterized by tunneling microscopy," *Phys. Rev. B* **43**, 8729-8732 (1991).
31. X.L. Wu and C.M. Lieber, "Applications of scanning tunneling microscopy to inorganic chemistry," *Prog. Inorg. Chem.* **39**, 431 (1991).
32. S.P. Kelty and C.M. Lieber, "Scanning tunneling microscopy investigations of the surface structure and electronic properties of ternary graphite intercalation compounds," *J. Vac. Sci. Technol. B* **9**, 1068-1071 (1991).
33. X.L. Wu and C.M. Lieber, "Variable-temperature scanning tunneling microscopy studies of the charge density wave phases in tantalum disulfide," *J. Vac. Sci. Technol. B* **9**, 1044 (1991).
34. Z. Zhang and C.M. Lieber, "Scanning tunneling microscopy and spectroscopy studies of the surface structure and electronic properties of single crystal Tl-Ba-Ca-Cu-O superconductors," *J. Vac. Sci. & Technol. B* **9**, 1009 (1991).
35. Z. Zhang, Y.L. Wang, X.L. Wu, J.L. Huang and C.M. Lieber, "The effects of oxygen doping on the electronic properties and microstructure of Bi₂Sr₂CaCu₂O_x superconductors determined by scanning tunneling microscopy," *2nd World Congress on Superconductivity* (World Scientific, Teaneck, 1991).
36. H. Dai, H. Chen and C.M. Lieber, "Weak pinning and hexatic order in a doped two-dimensional charge-density-wave system," *Phys. Rev. Lett.* **66**, 3183-3186 (1991).
37. S.P. Kelty, C.C. Chen and C.M. Lieber, "Superconductivity at 30 K in caesium-doped C₆₀," *Nature* **352**, 223 (1991).
38. C.C. Chen, S.P. Kelty and C.M. Lieber, "(Rb_xK_{1-x})C₆₀ Superconductors: formation of a continuous series of solid solutions," *Science* **253**, 886 (1991).
39. C.M. Lieber and X.L. Wu, "Scanning tunneling microscopy studies of low-dimensional materials: probing the effects of chemical substitutions at the atomic level," *Acc. Chem. Res.* **24**, 170 (1991).
40. S.P. Kelty, Z. Lu and C.M. Lieber, "Scanning-tunneling-microscopy investigations of ternary graphite intercalation compounds," *Phys. Rev. B* **44**, 4064-4067 (1991).

41. Y. Kim and C.M. Lieber, "Scanning tunneling microscopy imaging of synthetic oligonucleotides and oligonucleotide-metal complexes," *Scanning Microsc.* **5**, 311-316 (1991).
42. S.P. Kelty, Z. Lu and C.M. Lieber, "Core-level binding energies of Cs-doped C₆₀ and graphite," *J. Phys. Chem.* **95**, 6754-6756 (1991).
43. Z. Zhang, C.C. Chen, S.P. Kelty, H. Dai and C.M. Lieber, "The superconducting energy gap of Rb₃C₆₀," *Nature* **353**, 333 (1991).
44. Z. Zhang, C.-C. Chen and C.M. Lieber, "Tunneling spectroscopy of M₃C₆₀ superconductors: The energy gap, strong coupling, and superconductivity," *Science* **254**, 1619-1621 (1991).
45. C.M. Lieber and Y. Kim, "Characterization of the structural, electronic, and tribological properties of metal dichalcogenides by scanning probe microscopies," *Thin Solid Films* **206**, 355 (1991).
46. Z. Zhang and C.M. Lieber, "The energy gap of the M₃C₆₀ superconductors," *Mod. Phys. Lett. B* **5**, 1905 (1991).
47. Y. Kim, J.-L. Huang and C.M. Lieber, "Characterization of nanometer scale wear and oxidation of transition metal dichalcogenide lubricants by atomic force microscopy," *Appl. Phys. Lett.* **59**, 3404-3406 (1991).
48. Z. Zhang and C.M. Lieber, "Determination of the local structure and electronic states of high-T_c superconductors by scanning tunneling microscopy," *J. Phys. Chem.* **96**, 2030-2038 (1992).
49. Y. Kim, E.C. Long, J. K. Barton and C.M. Lieber, "Imaging of oligonucleotide-metal complexes by scanning tunneling microscopy," *Langmuir* **8**, 496 (1992).
50. Z. Zhang, C.-C. Chen, C.M. Lieber, B. Morosin, D.S. Ginley and E.L. Venturini, "Relationship between crystal chemistry and the local structure and electronic properties of Tl₂Ba₂Ca₂Cu₃O₁₀ superconductors determined by scanning tunneling microscopy and spectroscopy," *Phys. Rev. B* **45**, 987-992 (1992).
51. S.P. Kelty and C.M. Lieber, "Scanning tunneling microscopy investigations of graphite intercalation compounds," *CRC Critical Rev. Surf. Sci.* **1(4)**, 217 (1992).
52. C.-C. Chen and C.M. Lieber, "Synthesis of pure ¹³C₆₀ and determination of the isotope effect for fullerene superconductors," *J. Am. Chem. Soc.* **114**, 3141-3142 (1992).
53. C. Niu and C.M. Lieber, "The local structure of Bi_{2.2}Sr_{1.8}Cu_{1-x}Fe_xO_y single crystals determined by scanning tunneling microscopy," *J. Phys. Chem.* **96**, 3419-3423 (1992).
54. C. Niu and C.M. Lieber, "Low-temperature growth of the infinite layer phase of SrCuO₂ by pulsed laser deposition," *J. Am. Chem. Soc.* **114**, 3570-3571 (1992).

55. Y. Li, J.L. Huang and C.M. Lieber, "Temperature dependence of the energy gap in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ superconductors by high-resolution electron-energy-loss spectroscopy," *Phys. Rev. Lett.* **68**, 3240-3243 (1992).
56. Y. Kim and C.M. Lieber, "Machining oxide thin-films with an atomic force microscope: pattern and object formation on the nanometer scale," *Science* **257**, 375-377 (1992).
57. Z. Zhang and C.M. Lieber, "Oxygen doping $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ superconductors: Variations in the BiO-layer electronic states determined by scanning tunneling microscopy," *Phys. Rev. B* **46**, 5845-5848 (1992).
58. H. Dai and C.M. Lieber, "Solid-hexatic-liquid phases in two-dimensional charge-density waves," *Phys. Rev. Lett.* **69**, 1576-1579 (1992).
59. J.-L. Huang, Y.-E. Sung and C.M. Lieber, "Field-induced surface modification on the atomic scale by scanning tunneling microscopy," *Appl. Phys. Lett.* **61**, 1528-1530 (1992).
60. C. Niu and C.M. Lieber, "Growth of the infinite layer phase of $\text{Sr}_{1-x}\text{Nd}_x\text{CuO}_2$ by laser ablation," *Appl. Phys. Lett.* **61**, 1712-1714 (1992).
61. C. Niu and C.M. Lieber, "Exploiting laser based methods for low-temperature solid-state synthesis: Growth of a series of metastable $(\text{Sr}_{1-x}\text{M}_x)_{1-\delta}\text{CuO}_2$ materials," *J. Am. Chem. Soc.* **115**, 137-144 (1993).
62. C.C. Chen and C.M. Lieber, "Isotope effect and superconductivity in metal-doped C_{60} ," *Science* **259**, 655 (1993).
63. Z. Zhang and C.M. Lieber, "Measurement of the energy gap in oxygen-annealed $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ high- T_c superconductors by tunneling spectroscopy," *Phys. Rev. B* **47**, 3423-3426 (1993).
64. H. Dai and C.M. Lieber, "Charge density wave pinning and disorder in two dimensions," *J. Phys. Chem.* **97**, 2362-2367 (1993).
65. Y. Li and C.M. Lieber, "The energy gap in the high- T_c copper oxide superconductors," *Mod. Phys. Lett. B* **7**, 143 (1993).
66. C.M. Lieber and Y. Kim, "Nanomachining and manipulation with the atomic force microscope," *Adv. Mat.* **5**, 392 (1993).
67. Z. Zhang and C.M. Lieber, "Nanotube structure and electronic properties probed by scanning tunneling microscopy," *Appl. Phys. Lett.* **62**, 2792-2794 (1993).
68. Y. Li, J. Liu and C.M. Lieber, "Dependence of the energy gap on T_c : Absence of scaling in the copper oxide superconductors," *Phys. Rev. Lett.* **70**, 3494-3497 (1993).
69. D. Zhang, J.R. Norris, P.J. Krusic, E. Wasserman, C.-C. Chen and C.M. Lieber, "Time-resolved EPR and Fourier transform EPR Study of triplet C_{60} . determinations of T_1 and the ^{13}C hyperfine coupling constant," *J. Phys. Chem.* **97**, 5886-5889 (1993).

70. C. Niu, Y.Z. Lu and C.M. Lieber, "Experimental realization of the covalent solid carbon nitride," *Science* **261**, 334 (1993).
71. H. Dai and C.M. Lieber, "Scanning tunneling microscopy studies of low-dimensional materials: Charge density wave pinning and melting in two dimensions," *Ann. Rev. Phys. Chem.* **44**, 237 (1993).
72. C.M. Lieber, "Modification and manipulation of layered materials using scanned probe microscopies," *The Technology of Proximal Probe Lithography* (ed. C.R.K. Marrian, SPIE Optical Engineering Press, 1993).
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77. C.M. Lieber and C.C. Chen, "Preparation of fullerenes and fullerene based materials," *Solid State Physics* 48, (eds. H. Ehrenreich and F. Spaepen, Academic Press, 1994).
78. C.M. Lieber, "Scanning tunneling microscopy," *Chem. & Eng. News* **72**, 28 (1994).
79. C.M. Lieber and Z.J. Zhang, "Synthesis of covalent carbon nitride solids: Alternatives to diamond?" *Adv. Mat.* **6**, 497 (1994).
80. S. Yoon, H. Dai, J. Liu and C.M. Lieber, "Surface pinning as a determinant of the bulk flux-Line lattice structure in copper oxide superconductors," *Science* **265**, 215 (1994).
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82. C. Niu and C.M. Lieber, "Thin film synthesis of solids," *Encyclopedia of Inorganic Chemistry* **8**, 4151-4158 (ed. B. King, John Wiley & Sons, 1994).
83. A.M. Morales, P. Yang and C.M. Lieber, "Preparation of layered $\text{Sr}_2\text{CuO}_{3+\delta}$ by pulsed laser deposition: Rational synthesis and doping of a metastable copper oxide material," *J. Am. Chem. Soc.* **116**, 8360-8361 (1994).
84. H. Dai, S. Yoon, J. Liu, R.C. Budhani and C.M. Lieber, "Simultaneous observation of columnar defects and magnetic flux lines in high-temperature $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ superconductors," *Science* **265**, 1552-1555 (1994).

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91. A. Noy, C.D. Frisbie, L.F. Rozsnyai, M.S. Wrighton and C.M. Lieber, "Chemical force microscopy: Exploiting chemically-modified tips to quantify adhesion, friction, and functional group distributions in molecular assemblies," *J. Am. Chem. Soc.* **117**, 7943-7951 (1995).
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Lieber’s original work has resulted in more than 80 United States and International patents issued and pending. These breakthroughs have served as the underlying intellectual property for several small companies, including Nanosys, Inc., Nantero and Vista Therapeutics. Issued and pending United States patents are as follows:

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