

Mark G. Allen

Alfred Fittler Moore Professor of Electrical and Systems Engineering; and
Scientific Director, Singh Center for Nanotechnology
University of Pennsylvania

Biographical Sketch

Mark G. Allen received the B.A. degree in Chemistry, the B.S.E. degree in Chemical Engineering, and the B.S.E. degree in Electrical Engineering from the University of Pennsylvania, and the S.M. and Ph.D. (1989) from the Massachusetts Institute of Technology. From 1989 to 2013 he was a member of the faculty of the School of Electrical and Computer Engineering of the Georgia Institute of Technology, ultimately holding the rank of Regents' Professor and the J.M. Pettit Professorship in Microelectronics. In 2013 he joined the University of Pennsylvania faculty as the Alfred Fittler Moore Professor of Electrical and Systems Engineering, as well as being named the founding director of the Singh Center for Nanotechnology at Penn.

Professor Allen's current research interests are in the field of microfabrication and nanofabrication technology, with emphasis on new approaches to fabricate devices with characteristic lengths in the micro- to nanoscale from both silicon and non-silicon materials. He has published approximately 450 journal articles and conference proceedings, and holds nearly 60 patents (Google Scholar h-index of 79, with over 28,000 citations). He has graduated approximately 50 Ph.D. students in various disciplines, including electrical and computer engineering; chemical and biomolecular engineering; mechanical engineering; materials science; polymer, textile, and fiber engineering; and biomedical engineering. He was co-chair of the 1996 IEEE/ASME Microelectromechanical Systems Conference, the 2012 Power MEMS Conference, and chaired the 2016 Solid State Sensors, Actuators, and Microsystems Conference. He was Editor-in-Chief of the Journal of Micromechanics and Microengineering (a publication of the Institute of Physics) from 2009-2013, and is currently a member of the editorial board of Microsystems and Nanoengineering (Nature Publishing Group). He is a Fellow of the IEEE, and recipient of the 2016 IEEE Daniel P. Noble Award in Emerging Technologies for his work in MEMS. In 2017 he was elected to the National Academy of Inventors, and in 2020 received the IEEE Benjamin Franklin Key Award for outstanding electrical engineering design, innovation, and problem solving.

From 2007 to 2010, Professor Allen held the position of Senior Vice Provost for Research and Innovation at Georgia Tech. In that capacity had overall responsibility for management and growth of Georgia Tech's annual research budget, oversaw Georgia Tech's multiple interdisciplinary research centers, made strategic decisions on cost sharing and university investments in research, interfaced with the Federal Government through his supervision of Georgia Tech's Office of Federal Relations, and guided the commercialization of Georgia Tech research results and intellectual property. He has testified before Congress on intellectual property issues facing universities, and has given multiple invited talks on issues facing research universities in the 21st century. He has previously served as a member of the MIT Corporation Visiting Committee for Sponsored Research.

From 2011-2013, Professor Allen served as the founding Executive Director of the Institute for Electronics and Nanotechnology (IEN). IEN is charged with supervision and coordination of Georgia Tech's research activities across the continuum from nanotechnology to electronics, providing intellectual leadership for these activities, as well as management of Georgia Tech's substantial nanotechnology infrastructure investments.

Professor Allen is co-founder of several spinoff companies, including CardioMEMS (www.cardiomems.com), Axion Biosystems (www.axionbio.com), and Enachip (www.enachip.com). CardioMEMS was founded in 2001 has commercialized wireless implantable microsensors for treatment of aneurysms and congestive heart failure – ultimately becoming the first MEMS-based medical device transducers FDA-approved for permanent human implantation. The wireless aneurysm pressure monitor developed by CardioMEMS was highlighted by the FDA in its 2005 ODE annual report as a cleared medical device likely to have a significant impact on patient care. CardioMEMS completed a 550-patient clinical trial for its second product, a MEMS-based wireless implantable hemodynamic monitor for patients with congestive heart failure. After receiving FDA approval for its hemodynamic monitor, CardioMEMS was acquired by St. Jude Medical (now Abbott) in 2014. Axion Biosystems, founded in 2008, is commercializing microelectrode arrays for in-vitro electrogenic cell interfacing, for use in scientific study of neural and cardiac cells, as well as pharmaceutical screening. It is a revenue-generating company of approximately 50 employees, headquartered in Atlanta. In 2012, Axion won the Tibbetts Award, which honors outstanding small businesses, from the U.S. Small Business Administration. His latest venture, EnaChip, launched in 2017, is focused on exploiting nanoengineered materials for the realization of ultracompact power supplies.

I. EARNED DEGREES

Degree	Year	University	Area
Ph.D.	1989	Massachusetts Institute of Technology	Chemical Eng/Microelectronics
S.M.	1986	Massachusetts Institute of Technology	Chemical Engineering
B.S.E.E.	1988	University of Pennsylvania	Electrical Engineering
B.S.Ch.E.	1984	University of Pennsylvania	Chemical Engineering
B.A.	1984	University of Pennsylvania	Chemistry

II. EMPLOYMENT

Position	Employer	Dates
A.F. Moore Professor	University of Pennsylvania	2013-present
Executive Director	GT Institute for Electronics and Nanotechnology	2011-2013
Acting Director	GT Georgia Electronic Design Center	2010-2011
Senior Vice Provost, Research	Georgia Institute of Technology	2007-2010
Regents' Professor	Georgia Institute of Technology	2005-2013
Professor	Georgia Institute of Technology	1999-2013
Associate Professor (tenure)	Georgia Institute of Technology (GT)	1994-1999
Postdoctoral Associate	Massachusetts Institute of Technology	1989

III. SCHOLARLY PUBLICATIONS AND PRESENTATIONS

III.A. Published Books and Parts of Books

- Allen, M.G. and Senturia, S.D., "Microfabricated Structures for the Measurement of Adhesion and Mechanical Properties of Polymer Films," in Adhesives, Sealants, and Coatings for Space and Other Harsh Environments, pp. 501-508, (L.H. Lee, ed.), Plenum Press, New York, 1988.
- Allen, M.G., Nagarkar, P.V., and Senturia, S.D., "Aspects of Adhesion Measurement of Thin Polyimide Films," in Polyimides: Materials, Chemistry, and Characterization, pp. 705-717, (C. Feger, ed.) Elsevier Science Publishers, Amsterdam, 1989.
- Allen, M.G., *Special Tests For Membranes and Miniature Components*, in the American Society for Materials International Handbook Volume 3: Adhesives and Sealants, ASM Press, Metals Park, Ohio, 1990.
- Jardine, A.P., Johnson, G.C., Crowson, A., and Allen, M.G. (eds.), Smart Materials Fabrication and Materials for Microelectromechanical Systems, Materials Research Society Press, vol. 276, 1992.
- Hodge, T.C., Kohl, P.A., Bidstrup, S.A., Lee, J.B. and Allen, M.G., "In-Situ Thermal Expansion Measurements of Interlevel Dielectric Polymer Films", in Polyimides: Trends in Materials and Applications, pp. 287 - 302 (C. Feger, Mahmoud M. Khojasteh, Steven E. Molis Eds.), Connecticut: Society of Plastic Engineers, 1996.
- Arnold, D., and Allen, M.G., "Fabrication of Microscale Rotating Magnetic Machines," in Multi-Wafer Rotating MEMS Machines, (ed. Lang, J.H.), Springer, 2009.

III.B. Journal Publications

- Hasan, T., Allen, M.G., and Cooperman, B.S., "Anhydrotetracycline is a Major Product of Tetracycline Photolysis," *Journal of Organic Chemistry*, vol. 50, no. 10, pp. 311-313 (1985)
- Allen, M.G., Mehregany, M., Howe, R.T., and Senturia, S.D., "Microfabricated Structures for the In-Situ Measurement of Residual Stress, Young's Modulus, and Ultimate Strain of Thin Films," *Applied Physics Letters*, vol. 51, no. 4, pp. 241-244 (1987)
- Allen, M.G. and Senturia, S.D., "Analysis of Critical Debonding Pressures of Stressed Thin Films in the Blister Test," *Journal of Adhesion*, vol. 25, pp. 303-315 (1988)

4. Allen, M.G. and Senturia, S.D., "Application of the Island Blister Test for Thin Film Adhesion Measurement," *Journal of Adhesion*, vol. 29, pp. 219-231 (1989)
5. Allen, M.G., Nikolich, A., Scheidl, M., and Smith, R.L., "Movable Micromachined Silicon Plates with Integrated Position Sensing," *Sensors and Actuators*, A21-A23, pp. 211-214 (1990)
6. Camperi-Ginestet, C., Hargis, M., Jokerst, N., and Allen, M.G., "Alignable Epitaxial Liftoff of Gallium Arsenide Materials with Selective Deposition Using Polyimide Diaphragms," *IEEE Photonics Technology Letters*, vol. 3, no. 12, pp. 1123-1125 (1991)
7. Kim, Y.W. and Allen, M.G., "Single and Multilayer Surface Micromachined Platforms Using Electroplated Sacrificial Layers," *Sensors and Actuators*, A35, pp. 61-68 (1992)
8. Camperi-Ginestet, C., Kim, Y.W., Jokerst, N., Allen, M.G., and Brooke, M., "Three Dimensional Integrated Circuits: Compound Semiconductor Detectors Integrated Directly On Top Of Integrated Circuits," *IEEE Photonics Technology Letters*, vol. 4, no. 9, pp. 1003-6 (1992)
9. Frazier, A.B. and Allen, M.G., "Piezoresistive Graphite/Polyimide Thin Films for Micromachining Applications," *Journal of Applied Physics* (73), pp. 4428-4433 (1993)
10. Ahn, C.H. and Allen, M.G., "A Planar Micromachined Spiral Inductor for Integrated Magnetic Microactuator Applications," *Journal of Micromechanics and Microengineering*, vol. 3, no. 2, pp. 37-44 (1993)
11. Ahn, C.H. and Allen, M.G., "A Fully Integrated Surface Micromachined Magnetic Microactuator with a Multilevel Meander Magnetic Core," *IEEE Journal of Microelectromechanical Systems*, vol. 2, no. 1, pp. 15-22 (1993)
12. Frazier, A.B. and Allen, M.G., "Metallic Microstructures Fabricated Using Photosensitive Polyimide Electroplating Molds," *IEEE Journal of Microelectromechanical Systems*, vol. 2, no. 2, pp. 87-94 (1993)
13. Ahn, C.H., Kim, Y.J., and Allen, M.G., "A Planar Variable Reluctance Magnetic Micromotor with Fully Integrated Stator and Coils," *IEEE Journal of Microelectromechanical Systems*, vol. 2, no. 4, pp. 165-73 (1993)
14. Ahn, C.H. and Allen, M.G., "New Toroidal-Meander-Type Integrated Inductor with a Multilevel Meander Magnetic Core," *IEEE Transactions on Magnetics*, vol. 30, no. 1, pp. 73-79 (1994)
15. Ahn, C.H., Kim, Y.J., and Allen, M.G., "A Fully Integrated Planar Toroidal Inductor with a Micromachined Nickel-Iron Magnetic Bar," *IEEE Transactions on Components, Packaging, and Manufacturing Technology, Part A*, vol. 17, no. 3, pp. 463-469 (1994)
16. Frazier, A.B., Olson, C.S, Turner, S.P., and Allen, M.G., "Characterization of Graphite-Filled Polyimide Thin Films Using Micromachining Techniques," *International Journal of Microcircuits and Electronic Packaging*, vol. 17, no. 1, pp. 37-49 (1994)
17. Wilkinson, S.T., Kim, Y.W., Jokerst, N.M., and Allen, M.G., "Integration of Thin Film Optoelectronic Devices onto Micromachined Movable Platforms," *IEEE Photonics Technology Letters*, v. 6, n. 9, p. 1115-18 (1994)
18. Frazier, A.B., Ahn, C.H., and Allen, M.G., "Development of Micromachined Devices using Polyimide-Based Processes," *Sensors and Actuators A (Physical)*, vol. A45, no. 1, pp. 47-55 (1994)
19. Lee, J.B., Chen, Z., Allen, M.G., Rohatgi, A., and Arya, R., "A Miniaturized High-Voltage Solar Cell Array as an Electrostatic MEMS Power Supply," *IEEE Journal of Microelectromechanical Systems*, vol. 4, no. 3, pp. 102-108 (1995)
20. Carter-Coman, C., Brown, A.S., Bicknell-Tassius, R., Jokerst, N.M., and Allen, M.G., "Strain-Modulated Epitaxy: A Flexible Approach to 3-D Band Structure Engineering Without Surface Patterning," *Applied Physics Letters*, vol. 69, no. 2 pp. 257-259 (1996)
21. Ahn, C.H. and Allen, M.G., "A Comparison of Two Micromachined Inductors (Bar- and Meander-Type) for Fully Integrated Boost DC/DC Power Converters," *IEEE Transactions on Power Electronics*, vol. 11, no. 2, pp. 239-245 (1996)

22. Lee, J.B., Allen, M.G., Hodge, T.C., Bidstrup, S.A., and Kohl, P.A., "Modeling of Substrate-Induced Anisotropy in Through-Plane Thermal Behavior of Polymeric Thin Films," *Journal of Polymer Science, Part B (Polymer Physics)*, vol. 34, no. 9, pp. 1591-6 (1996)
23. Nami, Z., Ahn, C.H., and Allen, M.G., "An Energy-Based Design Criterion for Magnetic Microactuators," *Journal of Micromechanics and Microengineering*, vol. 6, no. 3, pp. 337-44 (1996)
24. Ahn, C.H., Allen, M.G., Trimmer, W., Jun, Y.-N., and Erramilli, S., "A Fully Integrated Micromachined Magnetic Particle Separator," *IEEE Journal of Microelectromechanical Systems*, v. 5, n. 3, pp. 151-8 (1996)
25. Lee, J.B., English, J., Ahn, C.-H., and Allen, M.G., "Planarization Techniques for Vertically Integrated Metallic MEMS on Silicon Foundry Circuits," *Journal of Micromechanics and Microengineering*, vol. 7, no. 2, pp. 44-54 (1997)
26. Lagorce, L.K. and Allen, M.G., "Magnetic and Mechanical Properties of Micromachined Strontium Ferrite/Polyimide Composites," *IEEE Journal of Microelectromechanical Systems*, v. 6, n. 4, pp. 307-12 (1997)
27. Frazier, A.B. and Allen, M.G., "Uses of Electroplated Aluminum for the Development of Microstructures and Micromachining Processes," *IEEE Journal of Microelectromechanical Systems*, vol. 6, no. 2, pp. 91-98 (1997)
28. Park, J.Y., Lagorce, L.K., and Allen, M.G., "Ferrite-Based Integrated Planar Inductors and Transformers Fabricated at Low Temperature," *IEEE Transactions on Magnetics*, vol. 33, no. 5, pt. 1, pp. 3322-3324 (1997)
29. Taylor, W.P., Brand, O., and Allen, M.G., "Fully Integrated Magnetically Actuated Micromachined Relays," *IEEE Journal of Microelectromechanical Systems*, vol. 7, no. 2, pp. 181-191 (1998)
30. Kim, Y.J., and Allen, M.G., "Surface Micromachined Solenoid Inductors for High Frequency Applications," *IEEE Transactions on Components, Packaging & Manufacturing Technology, Part C (Manufacturing)*, vol. 21, no. 1, pp. 26-33 (1998)
31. Chahal, P., Tummala, R.R., Allen, M.G., and Swaminathan, M., "A Novel Integrated Decoupling Capacitor for MCM-L Technology," *IEEE Transactions on Components, Packaging and Manufacturing Technology, Part B: Advanced Packaging*, vol. 21, no. 2, pp. 184-193 (1998)
32. Henry, S., McAllister, D.V., Allen, M.G., and Prausnitz, M.R., "Microfabricated Microneedles: A Novel Approach to Transdermal Drug Delivery," *Journal of Pharmaceutical Sciences*, v. 87, no. 8, pp. 922-5 (1998)
33. Park, J.Y. and Allen, M.G., "Development of Magnetic Materials and Processing Techniques Applicable to Integrated Micromagnetic Devices," *Journal of Micromechanics and Microengineering*, vol. 8, no. 4, pp. 307-316 (1998)
34. Taylor, W.P., Brand, O., and Allen, M.G., "Fully Integrated Magnetically Actuated Micromachined Relays," *IEEE Journal of Microelectromechanical Systems*, vol. 7, no. 2, pp. 181-191 (1998)
35. Chahal, P., Tummala, R.R., Allen, M.G., and Swaminathan, M., "A Novel Integrated Decoupling Capacitor for MCM-L Technology," *IEEE Transactions on Components, Packaging and Manufacturing Technology, Part B: Advanced Packaging*, vol. 21, no. 2, pp. 184-193 (1998)
36. Park, J.Y. and Allen, M.G., "Packaging-Compatible Microinductors and Microtransformers with Screen-Printed Ferrite using Low Temperature Processes," *IEEE Transactions on Magnetics*, vol. 34, no. 4, pt. 1, p.1366-8 (1998)
37. Ahn, C.H. and Allen, M.G. "Micromachined Planar Inductors on Silicon Wafers for MEMS Applications," *IEEE Transactions on Industrial Electronics*, vol.45, no.6, p.866-76 (1998)
38. Lagorce, L., Brand, O., and Allen, M.G., "Magnetic Microactuators Based on Polymer Magnets," *IEEE Journal of Microelectromechanical Systems*, vol.8, no.1, pp. 2-9 (1999)
39. Park, J.Y.; Allen, M.G., "Packaging-compatible high Q microinductors and microfilters for wireless applications," *IEEE Transactions on Advanced Packaging*, vol.22, no.2, pp. 207-13 (1999)
40. Kim, Y.J.; Allen, M.G., "In situ measurement of mechanical properties of polyimide films using micromachined resonant string structures," *IEEE Transactions on Components and Packaging Technologies*, vol.22, no.2, pp. 282-90 (1999)

41. Park, J.Y.; Han, S.H.; Allen, M.G., "Batch-fabricated microinductors with electroplated magnetically anisotropic and laminated alloy cores," *IEEE Transactions on Magnetics*, vol.35, no.5, pt.3, p.4291-4300 (1999)
42. Taylor, W.P.; Schneider, M.; Baltès, H.; Allen, M.G., "A NiFeMo electroplating bath for micromachined structures," *Electrochemical and Solid-State Letters*, vol.2, no.12, pp. 624-6 (1999)
43. Park, J.Y.; Allen, M.G., "High Q spiral-type microinductors on silicon substrates," *IEEE Transactions on Magnetics*, vol.35, no.5, pt.2, pp. 3544-6 (1999)
44. Bhattacharya, S.K.; Park, J.Y.; Tummala, R.R.; and Allen, M.G., "Fabrication of a Fully Integrated Passive Module for Filter Application using MCM-D Compatible processes," *J. Materials Science: Materials in Electronics*, vol. 11, no. 6, pp. 455-60 (2000)
45. Park, J.Y., and Allen, M.G., "Integrated Electroplated Micromachined magnetic Devices using Low Temperature Fabrication Processes," *IEEE Transactions on Electronics Packaging Manufacturing*, vol. 23, no. 1, pp. 48-55 (2000)
46. Seriburi, P.; Kercher, D.; Allen, M.G., "An Experimental Study of Microfabricated Spark Gaps: Wear and Erosion Characteristics," *J. Micromechanics Microengineering*, vol. 11, no. 3, pp. 165-74 (2001)
47. Park, J.W.; Park, J.Y.; Joung, Y.H.; Allen, M.G., "Fabrication of High Current and Low Profile Micromachined Inductor with Laminated Ni/Fe Core," *IEEE Transactions on Components and Packaging Technologies*, vol. 25, no. 1, pp. 106-111 (2002)
48. Fonseca, M.A.; English, J.M.; von Arx, M.; Allen, M.G., "Wireless Micromachined Ceramic Pressure Sensor for High Temperature Applications," *IEEE J. Microelectromechanical Systems*, v. 11, no. 4, pp. 337-43 (2002)
49. Chang, S.P.; Lee, J.B.; Allen, M.G., "A Robust Capacitive Pressure Sensor Array," *Sensors and Actuators A (Physical)*, vol. A101, no. 1-2, pp. 231-8 (2002)
50. Dongsu Kim; Yoonsu Choi; Allen, M.G.; Kenney, J.S.; Kiesling, D., "A wide-band reflection-type phase shifter at S-band using BST coated substrate" *IEEE Transactions on Microwave Theory and Techniques* , v 50, n 12, pp. 2903-9 (2002)
51. Allen, M.G., "MEMS technology for the fabrication of RF magnetic components" *IEEE Transactions on Magnetics*, v 39, n 5, pt.2, pp. 3073-8 (2003)
52. Yoon, Y.K.; Kim D.; Allen, M.G.; Kenney, J.S.; Hunt, A.T., "A reduced intermodulation distortion tunable ferroelectric capacitor-architecture and demonstration" *IEEE Transactions on Microwave Theory and Techniques* , v 51, n 12, pp. 2568-76 (2003)
53. Kim, D; Choi, Y.; Ahn, M.; Allen, M.G.; Kenney, J.S., "Monolithic 180 degrees and 360 degrees analog phase shifters based on barium strontium titanate coated sapphire substrates; *IEICE Transactions on Electronics* , v E86-C, n 8, pp. 1607-12 (2003)
54. Kaiser, T.J.; Allen, M.G., "A pendulous oscillating gyroscopic accelerometer fabricated using deep-reactive ion etching" *IEEE Journal of Microelectromechanical Systems* , v 12, n 1, pp. 21-8 (2003)
55. Park, J.W.; Allen, M.G., "Ultralow-profile micromachined power inductors with highly laminated Ni/Fe cores: application to low-megahertz DC-DC converters" *IEEE Transactions on Magnetics* , v 39, n 5, pt.2, p 3184-6 (2003)
56. Kim, D.; Choi, Y.; Ahn, M.; Allen, M.G.; Kenney, J.S.; Marry, P. "2.4 GHz continuously variable ferroelectric phase shifters using all-pass networks" *IEEE Microwave and Wireless Components Letters*, v 13, n 10, pp. 434-436 (2003)
57. Kercher, D.S.; Lee, J.B.; Brand, O.; Allen, M.G.; Glezer, A., "Microjet cooling devices for thermal management of electronics" *IEEE Transactions on Components and Packaging Technologies* , v 26, n 2, p 359-66 (2003)
58. Chang, S.P.; Allen, M.G., "Capacitive pressure sensors with stainless steel diaphragm and substrate" *Journal of Micromechanics and Microengineering* , v 14, n 4, pp. 612-18 (2004)

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.