

Adam E. Cohen

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Born: 30 May 1979, New York City

Research Statement

My lab develops new physical tools to study molecules and cells, and we apply these tools to make new measurements. We combine protein engineering, optics, microfluidics, electronics, and biochemistry to generate data; and we apply statistics and physical modeling to understand the data. Current projects include: development of fluorescent voltage-indicating proteins for all-optical electrophysiology; disease modeling in human induced pluripotent stem cells; studies on the nanomechanical properties of DNA; and development of techniques that combine image processing and optogenetics for functional screens in mammalian cells.

Employment

- 2013-present **Howard Hughes Medical Institute**
Investigator
- 2007-present **Harvard University**
Chemistry and Chemical Biology and Physics
Full Professor 2012 –
John L. Loeb Associate Professor of the Natural Sciences 9/2011 – 6/2012
Asst. Prof. 2007 – 2011
- 2006-2007 **Stanford University**
Postdoc in chemistry
Advisor: W. E. Moerner

Education

- 2003 - 2006 **Stanford University**
PhD in physics
Thesis: "Trapping and manipulating single molecules in solution"
Advisor: W. E. Moerner (Chemistry)
- 2001 - 2003 **Cambridge University**
PhD in physics
Thesis: "Nanoscale Mechanics"
Advisors: Michael Pepper (Semiconductor Physics, Cambridge); Shaul Mukamel (Theoretical Chemistry, UC Irvine); L. Mahadevan (SEAS, Harvard)
- 1997 - 2001 **Harvard University**
BA *summa cum laude*
Major: chemistry and physics
- 1991 - 1997 **Hunter College High School** (New York, NY)
First in a graduating class of 174

Honors and Awards

- 2014 ACS Pure Chemistry Award
- 2014 NIBIB Nagy New Investigator
- 2014 Blavatnik National Laureate in Chemistry
- 2012 Popular Science Brilliant 10: 10 most promising young scientists working today
- 2012 Dreyfus Teacher-Scholar Award
- 2011 Hunter College High School Distinguished Graduate Award
- 2010 Sloan Foundation Fellowship
- 2010 Presidential Early Career Award for Scientists and Engineers (PECASE)
- 2010 NIH New Innovator Award
- 2009 Defense Advanced Research Projects Agency Young Faculty Award
- 2009 Office of Naval Research Young Investigator Award
- 2007 Technology Review TR35: top 35 technology innovators under the age of 35
- 2007 Camille and Henry Dreyfus New Faculty Award
- 2006 Finalist in Collegiate Inventors Competition (Washington, DC)
for invention of a device to trap and manipulate single molecules.
- 2003 5-year Hertz Fellowship to study at Stanford University
- 2001 2-year Marshall Fellowship to study at Cambridge University
- 2001 Phi Beta Kappa
- 1999 2-year Goldwater Scholarship
- 1998 Inductee into the National Gallery for America's Young Inventors (Akron Ohio)
for invention of a nanoscale patterning technique using an electrochemical STM
- 1997 56th Westinghouse Science Talent Search: first place
for invention of a nanoscale patterning technique using an electrochemical STM

Other Activities

- 2016 - JASON advisory group. Technical advice to the US Government.
- 2013 - Co-founder, **Q-State Biosciences**. Biotechnology startup aimed at developing functional models of human neuropsychiatric, neurodegenerative, and cardiac diseases, using human induced pluripotent stem cells and advanced optical imaging. <http://www.qstate.com/>
- 2013 - Head Tutor, Chemical and Physical Biology undergraduate major, Harvard University
- 2008 - 2010 Scientific Advisory Board of ION Torrent Systems, <http://www.iontorrent.com/>
- 2008 - 2010 Scientific Advisor to Liberian Ministry of Education and the University of Liberia. <https://www2.lsddiv.harvard.edu/labs/cohen/Research/LiberianScience/LiberianScience.htm>
- 2008 - Co-director Engineering and Physical Biology PhD program, Harvard University

Book

- Let's Go 2000: Peru & Ecuador

Patents

- A. E. Cohen, "Nanoscale photolithography," U.S. patent 5,865,978 issued February 2, 1999
- A. E. Cohen, Charles Black, Robert Sandstrom, and Chris Murray, "Scanning probe microscopy Tips composed of nanoparticles and method to form same," U.S. patent 7,282,710 issued Oct. 16, 2007

- A. E. Cohen and W. E. Moerner, "Sub-micron object control arrangement and approach therefor," U.S. patent 8,057,655 issued Nov. 15, 2011
- A. E. Cohen, J. M. Kralj, A. D. Douglass, "Optogenetic probes of membrane potential," U.S. patent 9,057,734 issued June 16, 2015
- A. E. Cohen, Joel Kralj, Adam D. Douglass, Daniel Hochbaum, "Systems methods and workflows for optogenetics analysis," U.S. patent 9,207,237 issued Dec. 8 2015.
- A. E. Cohen, Daniel Hochbaum, Peng Zou, Samouil Farhi, Robert Campbell, Yongxin Zhao, Daniel Jed Harrison, "Optogenetic probes of membrane potential," U.S. patent 9,518,103 issued Dec. 13 2016
- A. E. Cohen, J. Kralj, A. D. Douglass, D. Hochbaum, "Systems, methods and workflows for optogenetics analysis," U.S. patent 9,702,874 issued Jul. 11, 2017.
- A. E. Cohen, J. Kralj, A. D. Douglass, "Optogenetic probes for measuring membrane potential," U.S. patent 9,791,455 issued Oct. 17, 2017.
- A. E. Cohen and Sabrina Leslie, "Convex Lens-Induced Confinement (CLIC) for measuring distributions of molecular sizes," U.S. patent pending
- A. E. Cohen, J. H. Hou, "Improvement to spinning disk microscopy", U.S. patent pending

Publications

* Indicates publications resulting from research since starting faculty position

Most significant publications in [blue](#).

- *75) Y. Adam, J. J. Kim, S. Lou, Y. Zhao, D. Brinks, H. Wu, M. A. Mostajo-Radji, S. Kheifets, V. Parot, S. Chettih, K. J. Williams, S. L. Farhi, L. Madisen, C. D. Harvey, H. Zeng, P. Arlotta, R. E. Campbell, A. E. Cohen, "All-optical electrophysiology reveals brain-state dependent changes in hippocampal subthreshold dynamics and excitability," bioRxiv, <https://doi.org/10.1101/281618> (2018)
- *74) M. P. Chien*, D. Brinks*, Y. Adam, W. Bloxham, S. Kheifets, A. E. Cohen, "Two-photon photoactivated voltage imaging in tissue with an Archaelhodopsin-derived reporter," bioRxiv, <https://doi.org/10.1101/211946> (2017)
- *73) C. A. Werley, M. P. Chien, A. E. Cohen, "An ultrawidefield microscope for high-speed fluorescence imaging and targeted optogenetic stimulation," *Biomedical Optics Express*, **8.12**, 5794-5813 (2017)
- *72) Y. Xu, P. Zou, and A.E. Cohen. "Voltage imaging with genetically encoded indicators." *Current Opinion in Chemical Biology*, **39**, 1-10, (2017)
- *73) H. Zhang, and A.E. Cohen. "Optogenetic Approaches to Drug Discovery in Neuroscience and Beyond," *Trends in Biotechnology*, **35.7**, 625-639, (2017)
- *71) C.A. Werley, M.P. Chien, J. Gaublomme, K. Shekhar, V. Butty, B.A. Yi, J.M. Kralj, W. Bloxham, L.A. Boyer, A. Regev, A.E. Cohen, "Geometry-dependent functional changes in iPSC-derived cardiomyocytes probed by functional imaging and RNA sequencing," *PloS One*, **12.3**, e0172671, (2017)
- *70) K. Ogden, W. Chen, S.A. Swanger, M.J. McDaniel, L.Z.Fan, C. Hu, A. Tankovic, H. Kusumoto, G.J. Kosobucki, A.J. Schulien, Z. Su, J. Pecha, S. Bhattacharya, S. Petrovski, A.E. Cohen, E. Aizenman, S.F. Traynelis, H. Yuan, "Molecular mechanism of disease-associated mutations in the pre-M1 helix of NMDA receptors and potential rescue pharmacology," *PLoS Genetics*, **13**, e1006536, (2017)
- *69) D. Brinks, Y. Adam, S. Kheifets, A.E. Cohen, "Painting with rainbows: patterning light in space, time, and wavelength for multiphoton optogenetic sensing and control," *Accounts of Chemical Research*, **49**, 2518-2526, (2016)
- *68) S. Lou, Y. Adam, E.N. Weinstein, E. Williams, K. Williams, V. Parot, N. Kavokine, S. Liberles, L. Madisen, H. Zeng, A.E. Cohen, "Genetically targeted all-optical electrophysiology with a transgenic Cre-dependent Optopatch mouse," *The Journal of Neuroscience*, **43**, 11059-11073, (2016)

- *67) Y. K. Cho, G. Zheng, G. J. Augustine, D. R. Hochbaum, A. E. Cohen, T. Knopfel, F. Pisanello, F. S. Pavone, I. M. Vellekoop, M. J. Booth, "Roadmap on neurophotonics." *Journal of Optics*, **18.9**, 93007-93032, (2016)
- *66) H. McNamara, H. Zhang, C.A. Werley, A.E. Cohen, "Optically controlled oscillators in an engineered bioelectric tissue," *Phys. Rev. X*, **6**, 031001 (2016)
- *65) H. Zhang, E. Reichert, A. E. Cohen, "Optical electrophysiology for probing function and pharmacology of voltage-gated ion channels," *eLife*, 10.7554/eLife.15202, (2016)
- *64) G. T. Dempsey, K. W. Chaudhary, N. Atwater, C. Nguyen, B. S. Brown, J. D. McNeish, A. E. Cohen, J. M. Kralj, "Cardiotoxicity screening with simultaneous optogenetic pacing, voltage imaging and calcium imaging," *J. Pharm. Tox. Meth.*, **81**, 240-250, (2016)
- *63) A. E. Cohen, "Optogenetics: turning the microscope on its head," *Biophys. J.*, **110.5**, 997, (2016)
- *62) A. S. Abdelfatta, S. L. Farhi, Y. Zhao, D. Brinks, P. Zou, A. Ruangkittisakul, I. Platasa, V. A. Pieribone, K. Ballanyi, A. E. Cohen, and R. E. Campbell, "A Bright and Fast Red Fluorescent Protein Voltage Indicator That Reports Neuronal Activity in Organotypic Brain Slices." *J. Neurosci*, **36.8**, 2458-2472 (2016)
- *61) M. J. Henderson, H. A. Baldwin, C. A. Werley, S. Boccardo, L. R. Whitaker, X. Yan, G. T. Holt, E. R. Schreiter, L. L. Looger, A. E. Cohen, D. S. Kim, B. K. Harvey "A Low Affinity GCaMP3 Variant (GCaMPer) for Imaging the Endoplasmic Reticulum Calcium Store." *PLoS One* **10.10**, e0139273 (2015)
- *60) V. Emiliani, A. E. Cohen, K. Deisseroth, M. Hausser, "All-Optical Interrogation of Neural Circuits." *J. Neurosci.* **35.41**, 13917-13926 (2015)
- *59) H. Lee, D. Brinks, A. E. Cohen, "Two-photon imaging of a magneto-fluorescent indicator for 3D optical magnetometry," *Optics Express* **23**, 28022-28030 (2015)
- *58) D. Brinks, A. J. Klein, A. E. Cohen, "Two-photon lifetime imaging of voltage indicating proteins as a probe of absolute membrane voltage," *Biophys. J.* **109**, 914-921 (2015)
- *57) M. J. Shon, A. E. Cohen, "Nano-mechanical measurements of protein-DNA interactions with a silicon nitride pulley." *Nucleic acids research* **44**, e7 (2016)
- *57) M. P. Chien, C. A. Werley, S. L. Farhi, A. E. Cohen, "Photostick: a method for selective isolation of target cells from culture," *Chem. Sci.* **6**, 1701-1705 (2015)
- *56) V. Venkatachalam, A. E. Cohen, "Imaging GFP-based reporters in neurons with multiwavelength optogenetic control," *Biophys. J.* **107**, 1554-1563 (2014)
- *55) D. Yang, A. E. Cohen, "Chirality-Dependent Friction of Bulk Molecular Solids," *Langmuir*, **30**, 9972-9976 (2014)
- *54) J. H. Hou, J. M. Kralj, A. D. Douglass, F. Engert, A. E. Cohen, "Simultaneous mapping of membrane voltage and calcium in zebrafish heart in vivo reveals chamber-specific developmental transitions in ionic currents," *Frontiers in Physiology: Cardiac Electrophysiology*, **5**, 344 (2014)
- *53) A. E. Cohen and V. Venkatachalam, "Bringing Bioelectricity to Light," *Annu. Rev. Biophys.* **43**, 211-232 (2014)
- *52) P. Zou, Y. Zhao, A. D. Douglass, D. R. Hochbaum, D. Brinks, C. A. Werley, D. J. Harrison, R. E. Campbell, A. E. Cohen, "Bright and fast multicoloured voltage reporters via electrochromic FRET", *Nature Communications*, **5**, 4625 (2014). See also: <http://arxiv.org/abs/1403.4636>.
- *51) D. Hochbaum*, Y. Zhao*, S. Farhi, N. Klapoetke, C. A. Werley, V. Kapoor, P. Zou, J. M. Kralj, D. Maclaurin, N. Smedemark-Margulies, J. Saulnier, G. L. Boulting, C. Straub, Y.K. Cho, M. Melkonian, G. K-S. Wong, D. J. Harrison, V. Murthy, B. Sabatini, E. S. Boyden, R. E. Campbell, A. E. Cohen, "All optical electrophysiology in mammalian neurons using engineered microbial rhodopsins," *Nature Methods*, **11**, 825-833 (2014)
- *50) V. Venkatachalam, D. Brinks, D. Maclaurin, D. Hochbaum, A. E. Cohen, "Flash Memory: photochemical imprinting of neuronal action potentials onto a microbial rhodopsin," *J. Am. Chem. Soc.* **136**, 2529-2537 (2014)

- *49) J. Hou, V. Venkatachalam, A. E. Cohen, "Temporal dynamics of microbial rhodopsin fluorescence reports absolute membrane voltage," *Biophysical Journal*, **106**, 639-648 (2014)
- *48) J. Park*, C. A. Werley*, V. Venkatachalam, S. Dib-Hajj, S. Waxman, A. E. Cohen, "Screening fluorescent voltage indicators with spontaneously spiking HEK cells," *PLoS One*, **8**, e85221 (2013)
- *47) A. P. Fields, E. A. Meyer, A. E. Cohen, "Euler buckling and nonlinear kinking of double-stranded DNA," *Nucleic Acids Research*, **41**, 9881-9890 (2013)
- *46) A. E. Cohen, D. R. Hochbaum, "Measuring membrane voltage with microbial rhodopsins," *Fluorescent Protein-Based Biosensors: Methods and Protocols*, J. Zhang, Q. Ni, R. H. Newman eds., Springer (2013)
- *45) D. Maclaurin*, V. Venkatachalam*, H. Lee, A. E. Cohen (*Co-first authors), "Mechanism of voltage-sensitive fluorescence in a microbial rhodopsin," *PNAS*, **110**, 5939-5944 (2013)
- *44) Y. Tang, L. Sun, A. E. Cohen "Chiroptical hot spots in twisted nanowire plasmonic oscillators," *Appl. Phys. Lett.* **102**, 043103 (2013)
- *43) M. W. Elting, S. R. Leslie, L. S. Churchman, J. Korlach, C. McFaul, J. S. Leight, M. J. Levene, A. E. Cohen, J. A. Spudich, "Single- molecule fluorescence imaging of processive myosin with enhanced background suppression using linear Zero Mode Waveguides (ZMW) and Convex Lens Induced Confinement (CLIC)," *Optics Express* **21**, 1189-1202 (2013)
- *42) A. P. Fields, A. E. Cohen, "Optimal tracking of a Brownian particle," *Optics Express*, **20**, 22585-22601 (2012)
- *41) M. J. Shon, A. E. Cohen, "Mass action at the single-molecule level," *J. Am. Chem. Soc.* **134**, 14618-14623 (2012)
- *40) J. Hou, A. E. Cohen, "Motion induced by asymmetric degradation of hydrogels," *Soft Matter*, **8**, 4616-4624 (2012)
- *39) J. Kralj*, A. D. Douglass*, D. R. Hochbaum*, D. Maclaurin, A. E. Cohen (*Co-first authors), "Optical recording of action potentials in mammalian neurons using a microbial rhodopsin," *Nature Methods*, **9**, 90-95 (2012)
- *38) H. Bayraktar, A. P. Fields, J. M. Kralj, J. L. Spudich, K. J. Rothschild, A. E. Cohen, "Ultrasensitive measurements of microbial rhodopsin photocycles using photochromic FRET," *Photochem. & Photobiol.*, **88**, 90-97 (2012)
- *37) H. Lee, N. Yang, A. E. Cohen, "Mapping nanomagnetic fields using a radical pair reaction," *Nano Letters*, **11**, 5367-5372 (2011)
- *36) J. Kralj, D. R. Hochbaum, A. D. Douglass, A. E. Cohen, "Electrical spiking in *Escherichia coli* probed with a fluorescent voltage-indicating protein," *Science*, **333**, 345-348 (2011)
- *35) A. E. Cohen and A. P. Fields, "The cat that caught the canary: What to do with single-molecule trapping," *ACS Nano*, **5**, 5296-5299 (2011)
- *34) A. P. Fields, A. E. Cohen, "Electrokinetic trapping at the one nanometer limit," *Proc. Natl. Acad. Sci. USA*, **108**, 8937-8942 (2011)
- *33) A. E. Cohen and W. E. Moerner, "Anti-Brownian Traps," in *Encyclopedia of Biophysics*, G. C. K. Roberts (Ed.) (Springer, Berlin, Heidelberg, appearing 2012)
- *32) Y. Tang and A. E. Cohen, "Enhanced enantioselectivity in excitation of chiral molecules by superchiral light," *Science*, **332**, 333-336 (2011)
- *31) N. Yang and A. E. Cohen, "Local geometry of electromagnetic fields and its role in molecular multipole transitions," *J. Phys. Chem. B*, **115**, 5304-5311 (2011)
- *30) N. Yang, and A. E. Cohen, "Optical imaging through scattering media via magnetically modulated fluorescence," *Optics Express*, **18**, 25461-25467 (2010)
- *29) S. R. Leslie, A. P. Fields, A. E. Cohen, "Convex Lens-Induced Confinement for imaging single molecules," *Anal. Chem.*, **82**, 6224-6229, (2010)
- *28) A. E. Cohen, A. P. Fields, J. H. Hou, S. Leslie, M. J. Shon, "In honor of W. E. Moerner: Confining molecules for single-molecule spectroscopy" *Israeli J. Chem.*, **49**, 275-282 (2010)

- *27) Y. Tang, A. E. Cohen, "Optical chirality and its interaction with matter," *Phys. Rev. Lett.* (cover story), **104**, 163901 (2010)
- *26) A. P. Fields, A. E. Cohen, "Anti-Brownian traps for studies on single molecules," *Methods in Enzymology*, **475**, 149-174 (2010)
- *25) A. E. Cohen, "Nanomagnetic Control of Intersystem Crossing" *J. Phys. Chem. A*, **113**, 11084–11092 (2009)
- *24) B. I. Rapoport, A. E. Cohen, "Teaching science and public health in postwar Liberia" Harvard-MIT HST Connector, Fall 2009.
- *23) Y. Tang, T. A. Cook, A. E. Cohen, "Limits on Fluorescence Detected Circular Dichroism of Single Helicene Molecules," *J. Phys. Chem. A*, **113**, 6213–6216 (2009)
- *22) N. Yang, Y. Tang, A. E. Cohen, "Spectroscopy in Sculpted Fields" *Nano Today* **4**, 269-279 (2009)
- *21) P. Jain, Y. Xiao, R. Walsworth, A. E. Cohen, "Surface Plasmon Resonance Enhanced Magneto-Optics (SuPREMO): Faraday Rotation Enhancement in Gold-Coated Iron Oxide Nanocrystals," *Nano Letters*, **9**, 1644–1650 (2009)
- 20) E. Tran, A. E. Cohen, R. W. Murray, M. A. Rampi and G. M. Whitesides, "Redox Site-Mediated Charge Transport in a Hg–SAM//Ru(NH₃)₆^{3+/2+}//SAM–Hg Junction with a Dynamic Interelectrode Separation: Compatibility with Redox Cycling and Electron Hopping Mechanisms," *J. Am. Chem. Soc.*, **131**, 2141-2150 (2009)
- 19) Y. Jiang, Q. Wang, A. E. Cohen, N. Douglas, J. Frydman, W. E. Moerner, "Hardware-based anti-Brownian electrokinetic trap (ABEL trap) for single molecules: Control loop simulations and application to ATP binding stoichiometry in multi-subunit enzymes," *Proc. SPIE*, **7038**, 703807, (2008)
- 18) A. E. Cohen and W. E. Moerner, "Controlling Brownian motion of single protein molecules and single fluorophores in aqueous buffer," *Optics Express*, **16**, 6941-6956 (2008)
- 17) A. E. Cohen and W. E. Moerner, "Principal Components Analysis of shape fluctuations of single DNA molecules," *Proc. Natl. Acad. Sci. USA*, **104**, 12622-12627 (2007)
- 16) A. E. Cohen and W. E. Moerner, "Internal mechanical response of a polymer in solution," *Phys. Rev. Lett.*, **98**, 116001 (2007)
- 15) A. E. Cohen and W. E. Moerner, "Suppressing Brownian motion of individual biomolecules in solution," *Proc. Natl. Acad. Sci. USA*, **103**, 4362-4365 (2006)
- 14) A. E. Cohen and W. E. Moerner, "An all-glass microfluidic cell for the ABEL trap: fabrication and modeling," *Proc. SPIE*, **5930** (2005)
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- 11) A. E. Cohen and W. E. Moerner, "The Anti-Brownian ELectrophoretic Trap (ABEL trap): Fabrication and Software," *Proc. SPIE*, **5699** (2005)
- 10) A. E. Cohen and W. E. Moerner, "Method for trapping and manipulating nanoscale objects in solution," *Appl. Phys. Lett.*, **86**, 093109 (2005)
- 9) A. E. Cohen, "Force-extension curve of a polymer in a high-frequency electric field," *Phys. Rev. Lett.* **91**, 235506 (2003)
- 8) A. E. Cohen and Shaul Mukamel, "Resonant enhancement and dissipation in nonequilibrium van der Waals forces," *Phys. Rev. Lett.* **91**, 233202 (2003)
- 7) A. E. Cohen, "Carbon nanotubes provide a charge," *Science* (letter to the editor) **300**, 1235 (2003)
- 6) A. E. Cohen and Shaul Mukamel, "A mechanical force accompanies fluorescence resonance energy transfer (FRET)," *J. Phys. Chem. A* **107**, 3633 - 3638 (2003)

- 5) A. E. Cohen and L. Mahadevan, "Kinks, Rings, and Rackets in Filamentous Structures," *Proc. Natl. Acad. Sci. USA* **100**, 12141 - 12146 (2003)
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- 2) A. E. Cohen, Andrew Gonzalez, John Lawton, Owen Petchey, Dennis Wildman, and Joel Cohen, "A novel experimental apparatus to study the impact of white noise and 1/f noise on animal populations," *Proc. R. Soc. Lond. B* **265**, 11-15 (1998)
- 1) Joel Cohen, Charles Newman, A. E. Cohen, Owen Petchey, and Andrew Gonzalez, "Spectral mimicry: a method of synthesizing matching time series with different Fourier spectra," *Circuits Systems and Signal Processing* **18**, 431-442 (1999)