Helen N. Schwerdt

Research Scientist
McGovern Institute for Brain Research
Koch Institute for Integrative Cancer Research
Massachusetts Institute of Technology
Cambridge, MA 02139
Phone: (703) 401-6959
Email: schwerdt@mit.edu

EDUCATION

Ph.D. (June 2014)	Electrical Engineering Arizona State University (Tempe, AZ)
M.S.E. (May 2009)	Electrical and Computer Engineering Johns Hopkins University (Baltimore, MD)
B.S. (May 2008)	Biomedical Engineering Johns Hopkins University (Baltimore, MD)

RESEARCH INTERESTS

My goal is to identify the multi-modal electrical and chemical brain signals underlying neurological disorders and to develop safer and more reliable implantable probes to diagnose and treat human disorders. My background in electrical and biomedical engineering, with more recent training in primate neurophysiology may help facilitate the pursuit of these goals.

RESEARCH EXPERIENCE

Postdoctoral
June 2014 – Present

Graybiel Lab and Convergence Products Lab
PI: Prof. Ann Graybiel, Co-PI: Prof. Michael Cima
Massachusetts Institute of Technology (Cambridge, MA)

The research involves developing new implantable tools to interrogate chemical signaling in deep brain structures of rodents and nonhuman primates. I built cell-sized implants capable of recording neurochemicals from the brain for >1 year. I am currently building chronic interfaces to probe both the co-active electrical oscillations and dopamine chemical signals prevalent in Parkinson's disease, in the brains of primates. Work involves microfabrication of implants in the cleanroom and development of customized hardware and software to record electrochemical fast scan cyclic voltammetry (FSCV) signals from multiple implanted probes. I perform implantation surgeries in rats and nonhuman primates (rhesus monkeys) and behavioral training and experiments. I am also involved in developing systems for remote neural recording in home-cage environments for the nonhuman primates and in developing devices for chronic micro-dosing of deep brain structures. We successfully implemented our new cellular-scale arrays in rodents to record dopamine from many sites in the brains of rodents and are now working on translating many of these techniques to record long-term large-scale activity in behaving primates. Ultimately, the goals of this project are to elucidate neurochemical basis of neurological disorders and allow translation of safer and more reliable diagnostics to improve treatment of Parkinson's disease.

Doctoral
Aug. 2009 – June 2014
Research Associate

MEMS for Biomedical Applications Lab
Advisor: Prof. Junseok Chae
Arizona State University (Tempe, AZ)

P.h.D. projects included developing implantable microsystems for passive wireless recording of neural signals and microvalves for regulating intracranial pressure for hydrocephalus treatment.

Wireless fully passive neurorecording microsystem using backscattering methods

We developed a novel neurorecording microsystem that operates through entirely passive nonlinear mixing operations to record and wirelessly backscatter targeted neuropotential signals without the need for any formal power supply or battery. Work involved design and simulation of antenna as embedded in stratified tissue media using finite element method (FEM) software (in HFSS) along with hybrid simulation using harmonic balance analysis (in ADS) of nonlinear passive mixer operations. Fabrication was done in a class 100 cleanroom using standard microfabrication techniques – photolithography, etching (RIE, DRIE, plasma, and chemical wet etching), and deposition (PECVD, sputtering, and evaporation). Tests revealed the microsystem's ability to record neuropotentials (in phantom and with real frog nerves) with amplitudes as low as few *mV*.

Wireless passive multichannel neurorecorder using multi-modal interrogation techniques

I leveraged the fully passive methods and integrated novel light-sensitive switches to enable fully passive recording of neuropotentials from multiple channels. Recording channels were activated and selected by irradiating light onto the circuit at different wavelengths specific to the switch for each channel.

Miniature hydrogel check valve for hydrocephalus treatment

Creating an implantable valve for alternative shunt treatment of hydrocephalus using hydrogel swelling mechanisms to effectively seal valve under low or negative pressure environments.

Masters

May 2008 – May 2009	Computational Sensory-Motor Systems Lab
Research Assistant	Advisor: Prof. Ralph Etienne-Cummings
	Johns Hopkins University (Baltimore, MD)

The M.S.E. thesis project was to develop a color detection glove for assisting the blind. This involved design and construction of hardware and electronics integrating optical sensor circuits, PC communication interfaces, and manually assembled tactile actuator arrays.

Predoctoral

Jan. 2006 – May 2009	Biomedical Instrumentation & Neuroengineering Lab
Research Assistant	Advisor: Prof. Nitish V. Thakor
	Johns Hopkins University (Baltimore, MD)

The research, wireless acquisition of neuropotentials, involved design and assembly of printed circuit boards (PCBs), programming wireless acquisition software and hardware, and testing and characterization of wireless transmission of neurorecording circuits with simulated neural signals.

June 2006 – Aug. 2006	Mechanical Engineering and Applied Mechanics Lab
Research Assistant	Advisor: Prof. Haim H. Bau
NSF Summer Research Fellowship	University of Pennsylvania (Philadelphia, PA)

Development of a magnetic microfluidic valve/pump using hybrid ferrofluid-wax materials.

TEACHING EXPERIENCE

Fall 2012 / 2013 — EEE 445/591 – Microwaves (Senior / Graduate Level Course)
Teaching Assistant

Course lab topics included network analyzer operation, S-parameters, waveguides, stub tuning and matching circuits, resonators, hybrids and couplers, and software design and simulation (HFSS and ADS). Responsibilities also included creating lab manuals and new lab material.

Spring 2013 — EEE 341 – Engineering Electromagnetics (Junior Level Course)
Teaching Assistant

Course lab topics included basic power measurements, standing wave ratio, waveguides, antennas, FDTD analysis using Matlab, and basic FEM simulation (HFSS).

AWARDS AND HONORS

2020 – 2022	Brain & Behavior Research Foundation NARSAD Young Investigator Grant	$35,000 / year
2018 – 2023	NIH / NINDS Pathway to Independence Award (K99/R00) Prospective R00 Phase, 2020 – 2023	$94,000 / year (K99) $250,000 / year (R00)
2015 – 2018	NIH Ruth L. Kirschstein National Research Service Award (NRSA) (F32) (Fellowship renewable up to 3 years cumulative)	$52,000 / year
2013	ASU Graduate College Summer Research Fellowship	$6,000
2012 – 2013	Arizona Board of Regents (ABOR) Doctoral Research Grant	$5,000
2012 – 2013	Achievement Rewards for College Scientists (ARCS) Award	$7,000
2012	ASU Graduate College Travel Grant	$350
2009 – 2012	NASA Graduate Student Research Program (GSRP) (Fellowship renewable up to 3 years cumulative)	$26,000 / year
2011	ASU GPSA JumpStart Research Grant	$500
2009	ASU Ira A. Fulton Award	$5,000

REFEREE ACTIVITIES

Frontiers Bioengineering, Batteries, Sensors and Actuators: A. Physical, Sensors and Actuators: B. Chemical, IEEE Transactions on Microwave Theory and Techniques, IEEE Transactions on Antennas and Propagation, IEEE Antennas and Wireless Propagation Letters, Journal of Power Sources, Journal of Computational Electronics, ACS Chemical Neuroscience

PUBLICATIONS

Journals

H.N. Schwerdt, E. Zhang, M.J. Kim, T. Yoshida, L. Stanwicks, S. Amemori, H.E. Dagdeviren, R. Langer, M.J. Cima, and A.M. Graybiel, "Cellular scale probes enable stable chronic subsecond monitoring of dopamine neurochemicals in a rodent model," *Communications Biology*, vol. 144, pp. 1–11., Sept. 2018.

C.D. Dagdeviren, K.B. Ramadi, P. Joe, K. Spencer, H.N. Schwerdt, H. Shimazu, S. Delcasso, K.I. Amemori, C. Nunez-Lopez, A.M. Graybiel, M.J. Cima, and R. Langer, "Miniaturized neural system for chronic, local intracerebral drug delivery," *Sci. Transl. Med.*, vol. 10, pp. 1–10, Jan. 2018.

H.N. Schwerdt, H. Shimazu, K. Amemori, S. Amemori, P.L. Tierney, D.J. Gibson, S. Hong, T. Yoshida, R. Langer, M.J. Cima, and A.M. Graybiel, "Long-term dopamine neurochemical monitoring in primates," *Proceedings of the National Academy of Sciences*, vol. 114, no. 50, pp. 13260–13265, Nov. 2017.

H.N. Schwerdt, M.J. Kim, S. Amemori, D. Homma, T. Yoshida, H. Shimazu, H. Yerramreddy, E. Karasan, R. Langer, A.M. Graybiel, and M. J. Cima, "Subcellular probes for neurochemical recording from multiple brain sites," *Lab Chip*, vol. 17, no. 6, pp. 1104–1115, March 2017. [PMID: 28233001]

H.N. Schwerdt, F.A. Miranda, and J. Chae, "Wireless Fully Passive Multichannel Recording of Neuropotentials Using Photo-Activated RF Backscattering Methods," *IEEE Transactions on Microwave Theory and Techniques*, vol. 63, no. 9, pp. 2965–2970, Sept. 2015.

H.N. Schwerdt, U.A. Amjad, J. Appel, A. Elhadi, T. Lei, M. Preul, R. Bristol, and J. Chae, "In Vitro Hydrodynamic, Transient, and Overtime Performance of a Miniaturized Valve for Hydrocephalus," *Annals of Biomedical Engineering*, vol. 43, no. 3, pp. 603–615, March 2015.

H.N. Schwerdt, R. Bristol, and J. Chae, "Miniaturized Passive Hydrogel Check Valve for Hydrocephalus Treatment," *IEEE Transactions on Biomedical Engineering*, vol. 61, no. 3, pp. 814–820, March 2014.

H.N. Schwerdt, F.A. Miranda, and J. Chae, "Analysis of Electromagnetic Fields Induced in Operation of a Wireless Fully Passive Backscattering Neurorecording Microsystem in Emulated Human Head Tissue," *IEEE Transactions on Microwave Theory and Techniques*, vol. 61, no. 5, pp. 2170–2176, May 2013.

H.N. Schwerdt, F.A. Miranda, and J. Chae, "A Fully Passive Wireless Backscattering Neuro-Recording Microsystem Embedded in Dispersive Human Head Phantom Medium," *IEEE Electron Device Letters*, vol. 33, no. 6, pp. 908–910, June 2012.

H.N. Schwerdt, W. Xu, S. Shekhar, A. Abbaspour-Tamijani, B. Towe, F. Miranda, and J. Chae, "A Fully-Passive Wireless Microsystem for Recording of Neuropotentials using RF Backscattering Methods," *IEEE/ASME Journal of Microelectromechanical Systems*, vol. 20, no. 5, pp.1119–1130, Oct. 2011.

Refereed Conference Proceedings

H. N. Schwerdt, M. J. Kim, E. Karasan, S. Amemori, D. Homma, H. Shimazu, T. Yoshida, R. Langer, A. M. Graybiel, and M. J. Cima, "Subcellular electrode arrays for multisite recording of dopamine in vivo," in *Proceedings of the IEEE International Conference on Micro Electro Mechanical Systems (MEMS)*, pp. 549–552, Las Vegas, NV, Jan. 2017.

H.N. Schwerdt, R. Bristol, and J. Chae, "An Implantable Hydrogel Check Valve for Hydrocephalus Treatment – Development and In Vitro Measurements," In *IEEE Solid-State Sensors, Actuators, and Microsystems Workshop*, pp. 355–358, Hilton Head Island, SC, June 2014.

H.N. Schwerdt, J. Chae, and F.A. Miranda, "Wireless Performance of a Fully Passive Neurorecording Microsystem Embedded in Dispersive Human Head Phantom," *IEEE International Symposium on Antennas and Propagation (APSURSI)*, pp. 1–2, Chicago, IL, July 2012.

H.N. Schwerdt, R. Bristol, and J. Chae, "Hydrogel Check Valve with Non-Zero Cracking Pressure for Use as a Potential Alternative Hydrocephalus Treatment Method," In *IEEE Solid-State Sensors, Actuators, and Microsystems Workshop*, pp. 137–140, Hilton Head Island, SC, June 2012.

H.N. Schwerdt, W. Xu, S. Shekhar, F. Miranda, and J. Chae, "Preliminary Thermal Characterization of a Fully-Passive Wireless Backscattering MEMS Neuro-Recorder," In *IEEE International Conference on Solid-State Sensors and Actuators (Transducers)*, pp. 1228–1231, Beijing, China, June 2011.

H.N. Schwerdt, W. Xu, S. Shekhar, A. Abbaspour-Tamijani, B. Towe, and J. Chae, "A Fully-Passive Wireless Microfabricated Neuro-Recorder," In *IEEE Solid-State Sensors, Actuators, and Microsystems Workshop*, pp. 258–259, Hilton Head Island, SC, June 2010.

H.N. Schwerdt, J. Tapson, and R. Etienne-Cummings, "A Color Detection Glove with Haptic Feedback for the Visually Disabled," In *IEEE Conference on Information Sciences and Systems (CISS)*, pp. 681–686, Baltimore, MD, May 2009.

Conference Abstracts

H.N. Schwerdt, M.J. Kim, E. Zhang, S. Amemori, T. Yoshida, R. Langer, M.J. Cima, and A.M. Graybiel, "Multi-site monitoring of subsecond dopamine neurochemical activity in rodents." In *Monitoring Molecules in Neuroscience 2018*. Poster 46. Oxford, UK. March 25, 2018.

H.N. Schwerdt, E. Zhang, M.J. Kim, S. Amemori, T. Yoshida, R. Langer, A.M. Graybiel, and M.J. Cima, "Cellular-scale arrays for multi-site neurochemical recording," In *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy (PittCon)*. Orlando, FL. Feb. 28, 2018.

H.N. Schwerdt, H. Shimazu, K. Amemori, S. Amemori, S. Hong, T. Yoshida, R. Langer, M.J. Cima, and A.M. Graybiel, "Electrochemical recording of pharmacologically modulated dopamine from sensors chronically implanted in striatum of awake non-human primates," In *Society for Neuroscience (SfN) Annual Meeting*, 047.15/T1, Washington D.C., Nov. 2017.

H.N. Schwerdt, M.J. Kim, D. Homma, S. Amemori, T. Yoshida, H. Shimazu, R. Langer, A.M. Graybiel, and M.J. Cima, "Flexible microelectrode arrays for high-density subsecond dopamine recording," In *Society for Neuroscience (SfN) Annual Meeting*, 752.08/MMM28, San Diego, CA, Nov. 2016.

H.N. Schwerdt, H. Shimazu, K. Amemori, S. Hong, J.C. Sy, K.C. Spencer, P.L. Tierney, Y. Yang, H. Yerramreddy, C. Dagdeviren, K. Ramadi, R.S. Langer, M.J. Cima, and A.M. Graybiel. "Fast-scan cyclic voltammetric measurements of stimulation-induced dopamine release with chronically implanted carbon fibers in awake non-human primate," In *Society for Neuroscience (SfN) Annual Meeting*, 266.03/BB33, Chicago, IL, Oct. 2015.

INVITED TALKS

"Long-term dopamine monitoring in primates," at the Neural Engineering Lab at Mayo Clinic (hosted by Dr. Kendall Lee). Rochester, MN. March 18, 2016.

"Subcellular neurochemical probes," at Brains on Brains Symposium at MIT. Cambridge, MA. May 1, 2017.

"Micro-invasive platforms for monitoring neurochemicals," at MIT Media Lab hosted by Dr. Canan Dagdeviren. Cambridge, MA. Nov. 3, 2017.

"Cellular-scale arrays for multi-site neurochemical recording," at a contributed session entitled 'Pushing the limits of in vivo neurotransmitter detection' (hosted by Dr. I. Mitch Taylor) at Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy (PittCon). Orlando, FL. Feb. 28, 2018.

TRAINEES SUPERVISED

Usamma Amjad, Arizona State University, Undergraduate in Chemical Engineering, Class of 2016, 2013 – 2015

Yuechen Mark Yang, Massachusetts Institute of Technology, Undergraduate in Electrical Engineering, Class of 2018, 2015 – 2016. Now engineer at Xilinx.

Harshita Yerramreddy, Wellesley College, Undergraduate in Neuroscience, Class of 2018, 2015 – 2017. Now software engineer at Google Verily.

Isabella Pecorari, Massachusetts Institute of Technology, Undergraduate in Brain and Cognitive Sciences, Class of 2019, 2016 – 2017

Ekin Karasan, Massachusetts Institute of Technology, Undergraduate in Electrical Engineering, Class of 2018, 2016 – 2017. Now at University of California, Berkeley, pursuing Ph.D.

Michelle Duan, Wellesley College, Undergraduate Chemistry, Class of 2019, 2016 – 2018

Hussein Emre Dagdeviren, Istanbul Cerrahpasa Faculty of Medicine (Istanbul, Turkey), Medical Student, Neurosurgery, Summer 2017

Elizabeth Zhang, Massachusetts Institute of Technology, Master's Student, Electrical Engineering, 2017 – 2018. Now at Stanford University pursuing Ph.D.

Karenna Groff, Massachusetts Institute of Technology, Undergraduate, Class of 2022, Summer 2018

Stuart Dillon Powell, Massachusetts Institute of Technology, Undergraduate in Electrical Engineering, Class of 2021, Summer 2018

Carl Alex Matisse, Johns Hopkins University, Undergraduate in Neuroscience, Class of 2021, Summer 2018

Busra Nur Agca. Hacettepe University School of Medicine (Ankara, Turkey), 3rd Year Medical Student, Summers 2018 and 2019

Kade Bose, Massachusetts Institute of Technology, Undergraduate in Electrical Engineering, Class of 2022, Spring 2019 – present

Jeanne L. Harabedian, Massachusetts Institute of Technology, Undergraduate in Brain and Cognitive Sciences, Class of 2020, Spring 2019

May Xia, Wellesley College, Undergraduate in Neuroscience, Class of 2020, Spring 2019 – present

Edgardo A. Letona Chavez, Massachusetts Institute of Technology, Undergraduate in Physics, Class of 2022, Spring 2019