Helen N. Schwerdt

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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 broad research interests are in microelectromechanical systems (MEMS), nonlinear microwave devices, wireless implantable devices, bioelectronics, and instrumentation for understanding and/or treating the brain and its related disorders. I am also interested in applying wireless modulation and/or interrogation schemes towards more clinically relevant applications including neuromodulation, drug delivery (ie. blood brain barrier), etc.

RESEARCH EXPERIENCE

Postdoctoral
June 2014 – Present

Convergence Products Lab
PI: Prof. Michael Cima
Massachusetts Institute of Technology (Cambridge, MA)

The research involves a novel therapeutic tool, the injectrode, to treat neurological disorders, with specific and direct implications towards the neurodegenerative disorder, Parkinson's disease. This device is a multifunctional electrode that can be used to direct both electrical and chemical stimuli locally to specific dysfunctional areas of the brain to focally perturb spatially restricted and/or cell-type specific neurons in conjunction with recording local electrical and chemical activity. This type of focalized treatment tries to circumvent the complications and limitations associated with systemic pharmacological treatments as well as the massive trauma induced by invasive deep brain stimulation (DBS) devices needed in more severe cases of this disease. Experiments involved are to study the use and performance of these devices in the brains of awake animals and record brain activity in response to device stimuli. The project involves a large interdisciplinary team incorporating multiple experts in neurosurgery, neuroscience,

chemical engineering, and materials science to develop these devices and we are also performing primate experiments to record and map out the areas of the brain that we are targeting for device implantation. Ultimately, this project may advance translation of safer and more reliable systems for actual improved treatment of brain disorders.

Doctoral

Aug. 2009 – June 2014
Research Associate

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

P.h.D. Research –

Wireless fully passive neurorecording microsystem using backscattering methods

Development of a highly unique and 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 source. Design involved simulating antenna characteristics in stratified tissue media using FEM (HFSS) along with hybrid simulation using harmonic balance analysis (ADS) for nonlinear passive mixer performance. 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

Devising a new technique that would conserve the beneficial properties of a fully passive circuit while allowing multiple recording channels. The idea was to integrate photo- sensitive and selective channels on the circuit and use light interrogation for activating multiple channels while preserving a similar nonlinear passive mixing and recording phenomena on individual channels.

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
Research Assistant

Computational Sensory-Motor Systems Lab
Advisor: Prof. Ralph Etienne-Cummings
Johns Hopkins University (Baltimore, MD)

M.S.E. Thesis – Development of a color detection glove for assisting the blind. This project 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
Research Assistant

Biomedical Instrumentation & Neuroengineering Lab
Advisor: Prof. Nitish V. Thakor
Johns Hopkins University (Baltimore, MD)

The research topic, wireless acquisition of neuropotentials, involved design/assembly of printed circuit boards (PCBs), programming wireless acquisition system on PC, and testing and characterization of wireless transmission of neurorecording circuits.

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

2015 – 2018	NIH Ruth L. Kirschstein National Research Service Award (NRSA) (F32)	$52,406 / year
2013	ASU Graduate College Summer Research Fellowship	$6,000
2012 – 2013	ABOR Doctoral Research Grant	$5,000
2012 – 2013	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

PUBLICATIONS

Journals

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 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, 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.

M. Mollazadeh, K. Murari, H.N. Schwerdt, X. Wang, N. Thakor, and G. Cauwenberghs, "Wireless Multichannel Acquisition of Neuropotentials," In *IEEE Biomedical Circuits and Systems Conference (BioCAS)*, pp. 49-52, Baltimore, MD, Nov. 2008.