

Marcus D. Gingerich

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Education

- Ph.D.** in Electrical Engineering, May 2002, University of Michigan, Ann Arbor, MI. "*Multi-Dimensional Microelectrode Arrays with On-Chip CMOS Circuitry for Neural Stimulation and Recording*"
- M.S.** in Electrical Engineering, Major: Solid State, Minor: Circuits and Electronics, December 1996, University of Michigan, Ann Arbor, MI.
- M.S.** in Bioengineering, Concentration: Bioelectrical, April 1994, University of Michigan, Ann Arbor, MI.
- B.S.** in Electrical Engineering, *Summa Cum Laude*, Options: Automatic Control, Electronics, Bioelectrical, February 1992, Michigan Technological University, Houghton, MI.

Research Interests

- Bio-MEMS, (MicroElectroMechanical Systems) application of solid state electronic fabrication technologies to interfacing with the human sensory and motor systems, particularly the central nervous system
- Neuroprosthetics
- Microelectrode arrays for stimulation of excitable tissue and recording of neural signals
- Solid state micro-fabrication technologies
- Design of microelectronics for implantable devices and systems
- Micropackaging and/or protection of implantable devices and systems

Current Position

Research Health Scientist: June 2003 to *present*, *Center for Innovative Visual Rehabilitation, VA Boston Healthcare System*, utilizing the Cornell Nanoscale Facility at Cornell University, Ithaca, NY.

- Develop microfabrication technologies for a chips-first high density interconnect technology for application in a retinal prosthesis under a VA Career Development Award grant.
- Develop microfabrication technologies for implantable, flexible, polymer-based microelectrode arrays and flexible substrates to build an *ab-externo* retinal prosthesis.

Previous Experience

Research Health Scientist: June 2002 to 2003, *Center for Innovative Visual Rehabilitation, VA Boston Healthcare System*, utilizing the Solid State Electronics Laboratory in the Department of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor, MI.

- Perform microfabrication tasks related to building an implantable retinal prosthesis including fabrication of polyimide-based microelectrode arrays, production of photolithographic mask plates, and deposition of iridium electrode metal.
- Developing a packaging and feedthrough scheme for the retinal implant project. This includes an extensive literature survey and a database development of relevant coating, packaging and feedthrough technologies. Design and fabrication of vehicles to test candidate packaging technologies.

Research Assistant: September 1992 to December 2001, University of Michigan, *Center for Wireless Integrated MicroSystems*, Department of Electrical Engineering and Computer Science, Ann Arbor, MI.

Designed, simulated, fabricated and tested two- and three-dimensional arrays of penetrating microelectrodes (probes) for neural stimulation and recording.

- Bulk-micromachined CMOS technology: integration of CMOS with bulk micro-machining to produce microelectrode structures with on-chip signal processing circuits: SUPREM for process simulation.
- Developed a simple new technique of corner compensation/protection for protecting CMOS circuitry from undercut during the bulk micro-machined device release etch.
- Designed and conducted *in-vitro* and *in-vivo* experiments for verification of proper and reliable probe function under normal operating conditions.

Memberships/Awards/Honors

VA Career Development Award, 2007-2010.

Member, The Association for Research in Vision and Ophthalmology, 2003-present.

Member, Eta Kappa Nu, Electrical Engineering Honor Society.

Member, Tau Beta Pi, Engineering Honor Society.

Leadership/Activities

Cornell Nanoscale Science and Technology Facility User Committee, 2011-present

Board of Trustees, Cornerstone Bible Fellowship, 2011-present

Secretary/Treasurer, Cornerstone Bible Fellowship, 2007- present

Publications/Presentations

S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, **M.D. Gingerich**, S.F. Cogan, W. Drohan, S. Behan, L. Theogarajan, J.L. Wyatt, J.F. Rizzo, "A Hermetic Wireless Subretinal Neurostimulator for Vision Prostheses." IEEE Trans. on Biomedical Engineering, in press, 2011.

M.D. Gingerich, Douglas B. Shire, Bruce McKee, John L. Wyatt, Joseph F. Rizzo, "Development of the Boston Retinal Prosthesis," Cornell Nanoscale Science and Technology Facility Annual Meeting, September 15, 2011, *invited talk*.

J.F. Rizzo, D. Shire, S. Kelly, P. Troyk, **M. Gingerich**, B. McKee, A. Priplata, J. Chen, W. Drohan, P. Doyle, O. Mendoza, L. Theogarajan, S. Cogan, J. Wyatt, "Development of the Boston Retinal Prosthesis." Proc. IEEE Engineering in Medicine and Biology Conference, 2011, pp. 3135-3138.

J.F. Rizzo, D. Shire, S. Kelly, P. Troyk, **M. Gingerich**, B. McKee, A. Priplata, J. Chen, W. Drohan, P. Doyle, O. Mendoza, L. Theogarajan, S. Cogan, J. Wyatt, "Overview of the Boston Retinal Prosthesis: Challenges and Opportunities to Restore Useful Vision to the Blind." Proc. IEEE Engineering in Medicine and Biology Conference, 2011, pp. 7492-7495.

S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, **M.D. Gingerich**, S.F. Cogan, W. Drohan, L. Theogarajan, J.L. Wyatt, J.F. Rizzo, "Communication and Control System for a 15-Channel Hermetic Retinal Prosthesis." Biomedical Signal Processing and Control, Vol. 6, No. 4, 2011, pp. 356-363.

M.D. Gingerich, R. Akhmechet, S.F. Cogan, W.A. Drohan, T. Plante, D.B. Shire, J.L. Wyatt, J.F. Rizzo III, "A Microfabricated Penetrating Electrode Array for a Subretinal Prosthesis"; Invest Ophthalmol Vis Sci., 2011, Vol. 52:4 4959.

D.B. Shire, T. Salzer, W.K. Jones, B. McKee, **M.D. Gingerich**, J.L. Wyatt, J.F. Rizzo, "Bonding and Packaging Advancements to the Boston Retinal Prosthesis"; Invest. Ophthalmol. Vis. Sci., 2011, Vol. 52:4 4966.

M.D. Gingerich, D.B. Shire, S.F. Cogan, T. Plante, J.L. Wyatt, J.F. Rizzo. "A Microfabricated Subretinal Electrode Array With an Integrated a-SiC Barrier," Invest. Ophthalmol. Vis. Sci. 2010 Vol. 51:4 3040.

J.F. Rizzo, J. Chen, P.R. Troyk, P. Doyle, J. Dumser, R. Akhmechet, **M.D. Gingerich**, S.K. Kelly, D.B. Shire. "Surgical Implantation in a Pig Eye of a Hermetic Retinal Prosthesis with Back Telemetry," Invest. Ophthalmol. Vis. Sci. 2010 Vol. 51:4 4317.

D.B. Shire, P. Doyle, S.K. Kelly, **M.D. Gingerich**, J. Chen, S.F. Cogan, W.A. Drohan, O. Mendoza, L. Theogarajan, J. Wyatt, J.F. Rizzo, "In-vivo operation of the Boston 15-channel wireless subretinal prosthesis," Proceedings of SPIE Vol. 7527, HVEI XV, January 2010. (presented by M.D. Gingerich)

D.B. Shire, S.K. Kelly, J. Chen, P. Doyle, **M.D. Gingerich**, S.F. Cogan, W. Drohan, O. Mendoza, L. Theogarajan, J.L. Wyatt, J.F. Rizzo. "Development and Implantation of a Minimally-Invasive, Wireless Sub-Retinal Neurostimulator." IEEE Trans. on Biomedical Engineering, Vol. 56, No. 10, Oct. 2009, pp. 2502-2511.

- S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, **M.D. Gingerich**, W.A. Drohan, L.S. Theogarajan, S.F. Cogan, J.L. Wyatt, J.F. Rizzo III. "The Boston Retinal Prosthesis: A 15-Channel Hermetic Wireless Neural Stimulator." In Proc. IEEE ISABEL International Symposium on Applied Sciences in Biomedical and Communication Technologies. Invited paper, 2009 - Received Best Paper Award.
- S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, **M.D. Gingerich**, W.A. Drohan, L.S. Theogarajan, S.F. Cogan, J.L. Wyatt, J.F. Rizzo III. "Realization of a 15-Channel, Hermetically-Encased Wireless Subretinal Prosthesis for the Blind." In Proc. IEEE Engineering in Medicine and Biology Conference, 2009, pp. 200-203.
- M.D. Gingerich**, R. Akhmechet, O.R. Ziv, D.B. Shire, J.L. Wyatt, J.F. Rizzo, III, "Microfabricated MultiElectrode Arrays for *in vitro* Studying Neural Coding in the Retina," Invest Ophthalmol Vis Sci. 2009; 50:ARVO E-Abstract 4587.
- D.B. Shire, S.K. Kelly, **M.D. Gingerich**, O. Mendoza, W. Drohan, J.H. Chen, J.F. Rizzo, III, J.L. Wyatt, "Long-Term in-vivo Operation of the Wireless Boston Retinal Neuroprosthesis," Invest Ophthalmol Vis Sci. 2009; 50:ARVO E-Abstract 4596
- J. Chen, S.J. Kim, J.E. Dumser, F. Shihab, C.Cai, R. Akhmechet, **M.D. Gingerich**, D.B. Shire, J.F. Rizzo, III, "Surgical Implantation of Penetrating Electrode Arrays in Minipig Eyes," Invest Ophthalmol Vis Sci. 2009; 50:ARVO E-Abstract 4585
- J.F. Rizzo, III, J. Chen, D. Shire, **M. Gingerich**, J. Sandell, S. Cogan, "Collective Summary of in vivo Experiments of Sub-Retinal Implantation of Microfabricated Electrode Arrays in Pigs," Invest Ophthalmol Vis Sci. 2009; 50:ARVO E-Abstract 4746
- Cogan SF, Ehrlich J, Plante TD, Smirnov A, Shire DB, **Gingerich M**, Rizzo JF, "Sputtered iridium oxide films for neural stimulation electrodes," J Biomed Mater Res Part B: Appl Biomater, 2008.
- M.D. Gingerich**, R. Akhmechet, D.B. Shire, J.L. Wyatt, J.F. Rizzo, "Development of a Flexible High-Density Multi-Layered Metallization Interconnect Technology for a Subretinal Prosthesis," Invest Ophthalmol Vis Sci. 2008;49:ARVO E-Abstract 3035
- D.B. Shire, S.K. Kelly, **M.D. Gingerich**, O. Mendoza, G. Swider, W. Drohan, J. Chen, J.F. Rizzo, J.L. Wyatt, "Operation of a Wirelessly Powered Subretinal Neurostimulator," Invest Ophthalmol Vis Sci. 2008;49:ARVO E-Abstract 3031
- J.F. Rizzo, III, J. Chen, D. Shire, S. Kelly, **M. Gingerich**, G. Swider, W. Drohan, J.L. Wyatt, "Implantation of a Wirelessly Powered Retinal Prosthesis Using an *ab externo* Surgical Technique," Invest Ophthalmol Vis Sci. 2008;49:ARVO E-Abstract 3027
- J. Chen, J. Loewenstein, S.J. Kim, M.A. Memon, L.S. Snebold, F. Masrur, **M.D. Gingerich**, D.B. Shire, "Surgical Implantation of Different Geometries of Electrode Arrays in Minipig Eyes," Invest Ophthalmol Vis Sci. 2008;49:ARVO E-Abstract 3036
- M.D. Gingerich**, D.B. Shire, J.L. Wyatt, J.F. Rizzo, "Development Toward a Flexible Passive Penetrating Electrode Array Technology for a Subretinal Prosthesis," Invest Ophthalmol Vis Sci. 2007;48:ARVO E-Abstract 673
- S.F. Cogan, J.Ehrlich, T.D. Plante, D.B. Shire, **M.Gingerich**, J.F. Rizzo, "Sputtered Iridium Oxide Films (SIROFS) for Retinal Stimulation Electrodes," Invest Ophthalmol Vis Sci. 2007;48:ARVO E-Abstract 660
- D.B. Shire, O.R. Ziv, **M.D. Gingerich**, R.Jensen, J.F. Rizzo, S.F. Cogan, J.L. Wyatt, "Progress Toward a Platform for Studying Neural Coding of Vision: Recordings From a Flexible, Transparent Multielectrode Array," Invest Ophthalmol Vis Sci. 2007;48:ARVO E-Abstract 658
- D.B. Shire, S.F. Cogan, **M.D. Gingerich**, J.L. Wyatt, and J.F. Rizzo, "Transparent Epiretinal Electrode Array for Chronic Recording to Study Neural Coding for Vision," Invest Ophthalmol Vis Sci. 2006;47:ARVO E-Abstract 3162

- L. Theogarajan, J. Wyatt, J. Rizzo, B. Drohan, M. Markova, S. Kelly, G. Swider, M. Raj, D. Shire, **M. Gingerich**, J. Lowenstein, and B. Yomtov, "Minimally invasive retinal prosthesis," IEEE Solid-State Circuits Conference, San Francisco, February 2006, pp.15-17
- M.D. Gingerich**, D.B. Shire, J. Chen, J. Loewenstein, H. Shah, J. Sun, J. Wyatt, J.F. Rizzo, "Surgical Guides for Electrode Array Implantation into the Subretinal Space," in Investigative Ophthalmology and Visual Science, vol. 46, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2005, Poster 1494/B263.
- J.L. Wyatt, J.F. Rizzo, L. Theogarajan, D.B. Shire, S.K. Kelly, **M.D. Gingerich**, S. Cogan, M. Markova, O. Ziv, "Engineering Development of a Prototype Wireless Subretinal Prosthesis," in Investigative Ophthalmology and Visual Science, vol. 46, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2005, Poster 1146.
- D. Shire, **M. Gingerich**, S. Cogan, T. Plante, S. Kelly, J.L. Wyatt, J.F. Rizzo, "Recent Developments in Inflatable Prosthesis for Epiretinal Stimulation and/or Recording," in Investigative Ophthalmology and Visual Science, vol. 46, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2005, Poster 1534/B303.
- M.D. Gingerich**, D.B. Shire, K. Karcich, C. Scholz, J. Wyatt, J.F. Rizzo, "Assembly and Packaging Developments for an *Ab Externo* Retinal Prosthesis," in Investigative Ophthalmology and Visual Science, vol. 45, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2004, Poster 4217/B678.
- K. J. Karcich, A. Buck, J. Wyatt, D. Shire, **M.D. Gingerich**, C. Scholz, J.F. Rizzo, "A System for Leakage Testing of Flexible Electronic Components," in Investigative Ophthalmology and Visual Science, vol. 45, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2004, Poster 4183/B644.
- D.B. Shire, **M. Gingerich**, S. Retterer, L. Theogarajan, S. Kelly, M. Markova, M. Raj, S. Cogan, J. Wyatt, J.F. Rizzo, "Design and Fabrication of an *Ab Externo* Retinal Prosthesis," in Investigative Ophthalmology and Visual Science, vol. 45, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2004, Poster 4177/B638.
- D.B. Shire, **M. Gingerich**, K. Karcich, A. Buck, R. Sweitzer, C. Scholz, S. Montezuma, J. Loewenstein, J. Franco-Sarabia, J. Wyatt, J. Rizzo, "Packaging Developments for Retinal Prostheses," in Investigative Ophthalmology and Visual Science, vol. 44, no. 4, presented at The Association for Research in Vision and Ophthalmology (ARVO), Ft. Lauderdale, FL, May 2003, Poster 5084/B743.
- Marcus D. Gingerich**, Jamille F. Hetke, David J. Anderson, and Kensall D. Wise, "A 256-Site 3D CMOS Microelectrode Array for Multipoint Stimulation and Recording in the Central Nervous System," *The 11th International Conference on Solid-State Sensors and Actuators (Transducers '01)*, pp. 416-419 June 2001.
- Marcus D. Gingerich**, "Active Stimulating and Recording Electrodes, Electronic Interfaces to the Central Nervous System," presentation at *IEEE SSCTC/EMB Workshop on Biomedical Electronics*, Arlington, VA, October 2000.
- Marcus D. Gingerich**, James A. Wiler, and Kensall D. Wise, "Use of an Active Microelectrode Array for Multipoint Stimulation and Recording in the Central Nervous System," Proceedings of The First Joint BMES/EMBS Conference, pp. 471, October 1999.
- Marcus D. Gingerich**, James A. Wiler, Kensall D. Wise and David J. Anderson, "Studies of Interconnections between Dorsal Cochlear Nucleus and Inferior Colliculus using Active Silicon Microprobes," Society for Neuroscience, Poster 267.14, Vol. 25, pp. 669, October 1999.
- Marcus D. Gingerich** and Kensall D. Wise, "An Active Microelectrode Array for Multipoint Stimulation and Recording in the Central Nervous System," The 10th International Conference on Solid-State Sensors and Actuators (Transducers '99), pp. 280-283, June 1999.
- Qing Bai, **Marcus D. Gingerich**, and Kensall D. Wise, "An Active Three-Dimensional Microelectrode Array for Intracortical Recording," Solid-State Sensor and Actuator Workshop, pp. 15-18, June 1998.