

### BIOGRAPHICAL SKETCH

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NAME Song, Yoon-Kyu	POSITION TITLE Associate Professor of Convergence Science and Technology
eRA COMMONS USER NAME (credential, e.g., agency login)	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE <i>(if applicable)</i>	MM/YY	FIELD OF STUDY
Seoul National University	B.S.	02/92	Electrical Engineering
Seoul National University	M.S.	02/94	Electrical Engineering
Brown University	Ph.D.	05/99	Electrical Engineering
Brown University	Postdoctoral	04/00	Electrical Engineering

#### A. Personal Statement

The goal of the proposed research is to develop a transformative microdevice-based technology to offer a non-pharmacological alternative via physical neuromodulation therapies. Among several research components identified as Tasks in the proposal, I am identified as one of the technological leaders and make a key contribution in Task 2: Development of Coherent Optical Techniques for Targeted Cortical Access through Scalp/Skull in Human Head Models, as well as Task 3: Biophysics of Neural Read-Write Modalities and Neural Decoding-Encoding.

I have the expertise, leadership and motivation necessary to successfully carry out the task in the proposed work. During my doctoral training period, I have obtained a broad background in Optoelectronics, with specific training and expertise in wide bandgap semiconductor light emitters. As an engineering staff at Agilent Technologies, Inc., I also carried out research and development of near infrared micro-lasers including GaAs VCSELs for data communication applications. Since my return to academia in 2003, I have focused on bioengineering research to develop advanced photonic and electronic devices/systems for neuroengineering applications. After joining Seoul National University, I have carried out a number of government sponsored research projects including development of efficient stimulation methods using plasmonic nanoparticles for optogenetically light sensitized neurons, development of electronic modules for biomimetic artificial cochlear, and development of ultra-low power microsystems for smart brain sensing network. Based on the previous education and research experience, I may conclude the proposed research is integrated seamlessly on my prior training and work. Also, as a result of the previous experiences, I am keenly aware of the importance of frequent communication among project members and of constructing a realistic research plan, timeline, and budget. In summary, I have a demonstrated record of accomplished and productive research projects in an area of optoelectronics and neural engineering, and my expertise and experience have prepared me to successfully perform the proposed project.

#### B. Positions and Honors

##### Positions and Employment

2000-2002	R&D Engineering Staff, Agilent Technologies, Inc., San Jose, CA
2003-2009	Assistant Professor (Research), Division of Engineering, Brown University, Providence, RI
2009-	Assistant Professor, Seoul National University, Seoul, Korea
2017-	Associate Professor, Seoul National University, Seoul, Korea
2010-2013	Adjunct Assistant Professor, Division of Engineering, Brown University, Providence, RI
2018-	Visiting Associate Professor, School of Engineering, Brown University, Providence, RI
2012-	Director, Center for Nano Bio Convergence Research, AICT, Suwon, Korea

**Other Experience and Professional Memberships**

- 1999- Member, Institute of Electrical and Electronics Engineers (IEEE)
- 1998- Member, American Physical Society
- 1997- Member, Optical Society of American
- 2005- Member, Society for Neuroscience

**C. Selected Peer-reviewed Publications (Selected from 42 peer-reviewed publications)**

**Most relevant to the current application**

1. S. Lee, T. Geiller, A. Jung, R. Nakajima, Y.-K. Song, B. J. Baker, "Improving a genetically encoded voltage indicator by modifying the cytoplasmic charge composition," *Scientific Reports*, vol. 7 (1), pp. 8286-, 2017
2. J. Lee, I. Ozden, Y.-K. Song, A. V. Nurmikko, "Transparent intracortical microprobe array for simultaneous spatiotemporal optical stimulation and multichannel electrical recording," *Nature methods*, vol. 12 (12), pp. 1157-1162, 2015
3. S. Lee, H. H. Piao, M. Sepheri-Rad, A. Jung, U. Sung, Y.-K. Song, B.J. Baker, "Imaging membrane potential with two types of genetically encoded fluorescent voltage sensors," *Journal of Visualized Experiments*, e53566-e53566, 2016
4. S. Kim, S. J. Jung, S. Y. Cho, Y.-K. Song\*, K.-S. Soh, S. Kim\*, "A Method for the Observation of the Primo Vascular System in the Thoracic Duct of a Rat," *Evidence-Based Complementary and Alternative Medicine*, vol. 2013, p. 536560, 2013.
5. S. Park, D. A. Borton, M. Kang, A. V. Nurmikko, Y.-K. Song\*, "An Implantable Neural Sensing Microsystem with Fiber-Optic Data Transmission and Power Delivery," *Sensors*, vol. 13, no. 5, pp. 6014-6031, 2013.

**Additional recent publications of importance to the field (in chronological order)**

1. H. J. Kim, S.-Y. Lee, L. H. Sinh, C. S. Yeo, Y. R. Son, K. R. Cho, Y.-K. Song, S. Ju, M. K. Shin, S.-J. Park, S. Y. Park, "Maximizing volumetric energy density of all-graphene-oxide-supercapacitors and their potential applications for energy harvest," *Journal of Power Sources*, vol. 346, pp. 113-119, 2017
2. S. J. Jung, H. Song, Y. Y. Kim, J. Kim, S. Kim, Y.-K. Song, K.-S. Soh, "Distribution of Mast Cells and Locations, Depths, and Sizes of the Putative Acupoints CV 8 and KI 16," *Evidence-Based Complementary and Alternative Medicine*, vol. 2017, e2953278, 2017
3. J. Lee, J. Jang, Y.-K. Song, "A review on wireless powering schemes for implantable microsystems in neural engineering applications," *Biomedical Engineering Letters*, vol. 6 (4), pp. 205-215, 2016
4. S. Kim, S. J. Jung, S. Y. Cho, Y.-K. Song\*, K.-S. Soh, S. Kim\*, "A Method for the Observation of the Primo Vascular System in the Thoracic Duct of a Rat," *Evidence-Based Complementary and Alternative Medicine*, vol. 2013, p. 536560, 2013.
5. S. Park\*, J. Lim, Y. E. Pak, S. Moon, Y.-K. Song\*, "A Solid State Nanopore Device to Investigate Magnetic Properties of a Single Magnetic Nanoparticle," *Sensors*, vol. 13, no. 6, pp. 6900-6909, 2013.
6. K. Joo, S.-K. Jerng, Y. S. Kim, B. Kim, S. Moon, D. Moon, G.-D. Lee, Y.-K. Song, S.-H. Chun, E. Yoon, "Reduction of graphene damages during the fabrication of InGaN/GaN light emitting diodes with graphene electrodes", *Nanotechnology*, 23(43), 435603, 2012.
7. S. H. Park, J. Park, D.-J. You, K. Joo, D. Moon, J. Jang, D.-U. Kim, H. Chang, S. Moon, Y.-K. Song, G.-D. Lee, H. Jeon, J. Xu, Y. Nanish, E. Yoon, "Improved emission efficiency of a-plane GaN light emitting diodes with silica nano-spheres integrated into a-plane GaN buffer layer", *Applied Physics Letters*, 100(19), 191116, 2012.
8. A. V. Nurmikko, J. P. Donoghue, L. R. Hochberg, W. R. Patterson, Y.-K. Song, C. W. Bull, D. A. Borton, F. Laiwalla, S. Park, Y. Ming, J. Aceros, "Listening to Brain Microcircuits for Interfacing With External World: Progress in Wireless Implantable Microelectronic Neuroengineering Devices," *Proceedings of the IEEE*, vol. 98, no. 3, pp. 375-388, 2010.
9. O. Ziv, E. Morales, Y.-K. Song, X. Peng, K. Odening, A. E. Buxton, A. Karma, G. Koren, B.-R. Choi, "Origin of Complex Behavior of Spatially Discordant Alternans in Transgenic Rabbit Model of LQT2," *Journal of Physiology*, vol. 587, no. 19, pp. 4661-4680, 2009.

10. W. Dong, R. Lee, H. Xu, S. Yang, K. Pratt, V. Cao, Y.-K. Song, A. V. Nurmikko, and C. D. Aizenman, "Neuronal Mediators of Visually-Guided Behavior in the Developing *Xenopus* Tadpole," *Journal of Neurophysiology*, vol. 101, no. 2, pp. 803-815, 2009.
11. H. Xu, J. Zhang, K. M. Davitt, Y.-K. Song, and A. V. Nurmikko, "Application of blue-green and ultraviolet micro-LEDs to biological imaging and detection," *Journal of Physics D: Applied Physics*, vol. 41, article no. 094013 (13pp), 2008.
12. H. Xu, K. M. Davitt, W. Dong, Y.-K. Song, W. R. Patterson, C. D. Aizenman, and A. V. Nurmikko, "Combining Multicore Imaging Fiber with Matrix Addressable Blue/Green LED Arrays for Spatiotemporal Photonic Excitation at Cellular Level," *IEEE Journal of Selected Topics in Quantum Electronics*, vol. 14, no. 1, pp. 167-170, 2008.
13. S. Venkataramani, K. M. Davitt, H. Xu, J. Zhang, Y.-K. Song, B. W. Connors, A. V. Nurmikko, "Semiconductor ultra-violet light-emitting diodes for flash photolysis," *Journal of Neuroscience Methods*, vol. 160, no. 1, pp. 5-9, 2007.

## D. Research Support

### Ongoing Research Support

- |  |           |                   |
|--|-----------|-------------------|
| NRF 0490-20170068 (Korea)<br>Basic Science Research Program<br>Microscale neural stimulation and recording system using transparent ZnO semiconductor multi-optrode array.<br>Role: PI   | Song (PI) | 11/01/16-10/31/18 |
| NRF 0490-20170068 (Korea)<br>Brain Research Program<br>Development of a Wireless Brain Machine Interface Microsystem for ECoG Signals in Primates.<br>Role: PI   | Song (PI) | 06/01/16-12/31/18 |
| NRF 0490-20170068 (Korea)<br>Biomedical Technology Program<br>Development of Neuro-mimetic Retinal Stimulation Using LCP-Based High Resolution Micro-Stimulators.<br>Role: PI  | Song (PI) | 06/01/17-01/29/19 |
| ADD 550-20170056 (Korea)<br>MEMS based Advanced Brain Machine Interface in Small Animals<br>The goal of this study is to develop a micro-miniaturized brain machine interface system for rodents and birds using MEMS neural probe technology with bio-energy harvesting.<br>Role: Co-Investigator | Seo (PI)  | 06/01/17-12/31/19 |
| NRF 5267-20180100 (Korea)<br>Smart Humanity Research Center<br>The goal of this project is to educate graduate and post-graduate researchers in the field of convergence science and technology.<br>Role: Co-Investigator  | Kwak (PI) | 03/01/13-02/28/20 |

### Completed Research Support

- |  |           |                   |
|--|-----------|-------------------|
| NRF 490-20120028 (Korea)<br>Development of efficient neural stimulation technology using optogenetics<br>The goal of this project is to develop a method for efficient neural stimulation of optogenetically light sensitized neurons using plasmonic nanoparticles.<br>Role: PI | Song (PI) | 09/01/10-08/31/13 |
|--|-----------|-------------------|

MSB 490-20140033 (Korea) Song (PI) 09/01/12-08/31/14  
High power LED with integrated microchannel heat spreader  
The goal of this project was to develop LEDs integrated with miniaturized aluminum heat spreader for high power spot lighting applications.  
Role: PI

NRF 0414-20140008 (Korea) Kim (PI) 09/01/09-02/28/15  
Development of an electronic module for an artificial cochlear with biomimetic basilar membrane  
The goal of this project was to develop a compact ultra-low power electronic module that can be completely implanted with biomimetic artificial basilar membrane for an advance auditory prosthesis.  
Role: Co-Investigator

MKE 0627-20120004 (Korea) Park (PI) 03/01/10-02/28/13  
Nanopore based next-generation DNA sequencer  
This project was to develop a new DNA sequencing technology based on signals related to translocation of DNA through nanopore in a membrane of inorganic material.

NRF 0543-20140017 (Korea) Song (PI) 09/29/11-08/31/15  
Global Frontiers Project  
Smart Brain Sensor Network  
The goal of this project was to develop a wireless neural sensor network that can be completely implanted in the human brain.  
Role: PI

NRF 0627-20110004 (Korea) Han (PI) 09/01/09-02/28/13  
THz Spectroscopy of Biomolecules  
The goal of this project was to develop a new spectroscopy system based on THz waves that can characterize physical and chemical properties of biomolecules.  
Role: Co-Investigator