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Minimally Invasive Neural Interfaces: Battery-free Bioelectronics and Lensless Microscopes

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Abstract: Miniature implanted devices capable of manipulating and recording biological signals promise to improve the way we study biology and the way we diagnose and treat disease; however, to create technologies that are both small and effective we must overcome myriad engineering challenges. In this talk, I will describe two efforts to create these minimally invasive bioelectronics. In the first case I will describe flat, lensless microscopes that can image brain activity in mice and non-human primates [1]. In the second case, I will describe miniature, battery-free bioelectronic technologies that receive data and power via magnetoelectric materials. These materials offer a platform for safe and reliable power delivery for networks of miniature bioelectronic implants capable of distributed closed-loop therapies [2,3]. Overall, these approaches for minimally invasive bioelectronics could support next-generation brain-computer interfaces and more effective bioelectronic medicine.

1. Adams, J.K., Yan, D., Wu, J. et al. In vivo lensless microscopy via a phase mask generating diffraction patterns with high-contrast contours. Nat. Biomed. Eng. (2022). https://doi.org/10.1038/s41551-022-00851-z
2. Singer, A., Dutta, S., Lewis, E. et al. Magnetoelectric Materials for Miniature, Wireless Neural Stimulation at Therapeutic Frequencies, Neuron (2020). https://doi.org/10.1016/j.neuron.2020.05.019
3. Chen, J.C., Kan, P., Yu, Z. et al. A wireless millimetric magnetoelectric implant for the endovascular stimulation of peripheral nerves. Nat. Biomed. Eng. (2022). https://doi.org/10.1038/s41551-022-00873-7

Bio: Dr. Jacob Robinson received a B.S. in Physics from UCLA in 2003 and a Ph.D. in Applied Physics from Cornell University in 2008 under advisor Dr. Michal Lipson. After completing his Ph.D., studying silicon nanophotonics, he began postdoctoral research in the Department of Chemistry and Chemical Biology at Harvard University. While at Harvard, Jacob developed silicon nanowire devices to probe the electrical and chemical activity of living cells. In the summer of 2012, he joined the ECE and BioE departments at Rice. He is currently interested in developing nanofabricated devices to study the structural and functional dynamics of living neural circuits.