

Spencer R. Averbek

Philadelphia, PA • Phone: 763-233-2932 • Email: saverb@seas.upenn.edu

SUMMARY

Bioengineer with expertise in neural electrode design, electrochemical characterization and cleanroom microfabrication. Expertise with thin-film and direct ink-write (DIW) MXene-based bioelectronics; from material design and fabrication optimization to clinical sterilization validation and electrochemical performance characterization for acute and chronic recording and stimulation. Designed, developed, fabricated, and deployed novel DIW devices in first-in-human intraoperative use cases, recording pathological and stimulus-evoked neural activity.

EDUCATION

University of Pennsylvania

Ph.D. in Bioengineering

Philadelphia, PA
Expected Oct 2025

- Advisors: Flavia Vitale & Michael Beauchamp
- GPA 3.72/4.00

University of Wisconsin-Madison

B.S. in Biomedical Engineering

Madison, WI
May 2021

- Emphasis in Bioinstrumentation
- GPA: 3.54/4.00

RELEVANT EXPERIENCE

Graduate Student: Center for Neuroengineering and Therapeutics (CNT)

Aug. 2021 – Present

University of Pennsylvania, Philadelphia, PA

- Designed, fabricated, and structurally / electrochemically characterized response to clinical sterilization processes in novel bioelectronics for translational therapeutic applications.
- Characterized size scaling electrochemical effects of $Ti_3C_2T_x$ electrodes for neural recording and stimulation.
- Varied fabrication protocols with devices encapsulated with Parylene-C, Polyimide, PDMS, and SU8
- Redesigned and optimized a new thin-film microfabrication process within the university cleanroom facility.
- Completed the first ever in-human application of DIW printed neural μ ECoG for MXene-based bioelectronics.
- Mentored current and incoming members of the lab on current techniques and processes regularly used.

Undergraduate Researcher: Ludwig Lab, WITNe

Nov. 2018 – Aug. 2021

Wisconsin Institute for Medical Research, Madison, WI

- Designed fabricated and tested custom Platinum disc electrodes for benchtop experiments to determine their clinical implications and potential for neural applications.
- Conducted electrochemical measurements such as cyclic voltammetry, electrochemical impedance spectroscopy, and voltage transients on electrodes to understand implications of recording and stimulation capabilities.
- Assisted lab members performing numerous rodent craniotomies and ‘headcap’ lens placement procedures.
- Studied electrochemical literature and its effects on the electrode-tissue interface as well as long-term degradation mechanisms in *in-vivo* applications.

PUBLICATIONS

- Shankar, S., Chen, Y., **Averbek, S.R.**, Hendricks, Q., Murphy, B., Ferleger, B., ... & Vitale, F. **2025**. Transparent MXene Microelectrode Arrays for Multimodal Mapping of Neural Dynamics. *Advanced healthcare materials*, 14(4), 2402576.
- **Averbek, S. R.**, Xu, D., Murphy, B. B., Shevchuk, K., Shankar, S., Anayee, M., ... & Vitale, F. **2023**. Stability of $Ti_3C_2T_x$ MXene Films and Devices under Clinical Sterilization Processes. *ACS nano*. 17, 10, 9442–9454
- Garg, R., Driscoll, N., Shankar, S., Hullfish, T., Anselmino, E., Iberite, F., **Averbek, S. R.**... & Vitale, F. **2022**. Wearable High-Density MXene-Bioelectronics for Neuromuscular Diagnostics, Rehabilitation, and Assistive Technologies. *Small Methods*, 2201318.
- Trevathan, J., **Averbek, S. R.**, Gholston, A., & Ludwig, K. **2022**. ID: 16079 The Importance of Instrumentation on Measurement of Safe Charge Injection Limits at Neural Stimulation Electrodes. *Neuromodulation: Technology at the Neural Interface*, 25(4), S52.

CONFERENCE PRESENTATIONS

- **Averbeck, S. R.,** Garg, R.,... Beauchamp, M.S., & Vitale, F. “Fully printed 126-channel $\text{Ti}_3\text{C}_2\text{T}_x$ MXene micro-ECoG array captures pathological and auditory-evoked cortical activity in intraoperative recordings from human neurosurgical patients” Poster Presentation, Society for Neuroscience, San Diego, CA, Nov. 18, **2025**
- **Averbeck, S. R.,** ... & Vitale, F. “Scaling of Electrochemical Performance of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene Microelectrode Arrays for Recording and Stimulation” Oral Presentation, MRS Spring Meeting, Seattle, WA, Apr. 24, **2024**.
- **Averbeck, S. R.,** Xu, D., Murphy, B. B., ... & Vitale, F. “Stability of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene Electrode Arrays Under Different Sterilization Conditions.” Oral Presentation, MRS Fall Meeting, Boston, MA, Dec. 1, **2022**.

SELECTED PROJECTS

Fully Printed μECoG Captures Dynamic Cortical Activity Intraoperatively from Humans Jan. 2024 – Present
University of Pennsylvania, Philadelphia, PA

- Conducted first-ever in-human neural monitoring with MXene-based bioelectronics during several acute intra-operative procedures at HUP (Hospital of University of Pennsylvania)
- Created and optimized direct-write fabrication protocol that directly prints conductive traces and low-cure-temp transparent polyimide encapsulation for fully customizable, and high-density microelectrodes in under 6 hours

Size Scaling of Electrochemical Performance of Microelectrodes for Recording & Stim June 2023 – Present
University of Pennsylvania, Philadelphia, PA

- Established recording and stimulation capabilities of MXene-based thin-film microelectrodes as a function of contact size through equivalent circuit modeling and electrochemical characterization with EIS, CV, and VT.

Stability of $\text{Ti}_3\text{C}_2\text{T}_x$ Bioelectronics under several Clinical Sterilization Processes Jan. 2022 – May 2023
University of Pennsylvania, Philadelphia, PA

- Characterized the functional, structural, and mechanical stability of thin-film and composite bioelectronics under several clinical sterilization processes to understand clinical translatability and stability of custom electrodes.

Capstone Design Project: Biofeedback Device for Prevention of Migraines Sep. 2020 – May 2021
University of Wisconsin-Madison, Madison, WI

- Lead the design fabrication and validation of the EMG and thermistor circuit used in the biofeedback device.

Design Project: Stimdia Medical: Neck Anatomy Simulator Sep. 2019 – Dec. 2019
University of Wisconsin-Madison, Madison, WI

- Organized the efforts of a 5-member team in fabricating a high-fidelity simulation of the neck anatomy surrounding the phrenic nerve.

Design Project: Electrode Array for Transcutaneous Stimulation after SCI Sep. 2018 – Dec. 2018
University of Wisconsin-Madison, Madison, WI

- Developed testing parameters and efficacies of deep ‘target nerve’ stimulation using multiple electrode array sizes and orientations.

SKILLS

Electrochemistry: EIS, CV, VT, Equivalent Circuit Model fitting and quantification, acute & long-term stability analysis

Microfabrication: Lithography, PVD, CVD, wet/dry etching, thin-film deposition, DIW printing, photomask design

Instrumentation: SEM, XRD, EDX, Raman, profilometry, PCB prototyping, soldering, ACF bonding, circuit analysis

Software: Python, EAGLE Autodesk, AutoCAD, MATLAB, Arduino, Microsoft suite

Surgical Techniques: Device packaging, sterilization, intraoperative electrode handling, time-synchronized O.R. stimuli

LEADERSHIP / MENTORING

University of Pennsylvania Philadelphia, PA
Teaching Assistant Jan. 2023 – May 2023

- Informed students about the transduction and acquisition of neural signals during recitation session
- Assisted students in weekly office hours with their machine learning coding questions related to homework

Student Mentor Jan. 2022 – Present

- Motivated young Philadelphia high-school students to further their interests in engineering with interactive demos

INTERESTS

Dog dad (+5 years), anime enthusiast, cooking amateur, enjoyer of running, biking hiking, fishing, and exploring