NSF-ERC-Center for Sensorimotor Neural Engineering Undergraduate Research at SDSU

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Lab Directors: Dr. Samuel Kassenge, Dr. Yusuf Ozturk, Dr. Khaled Morsi

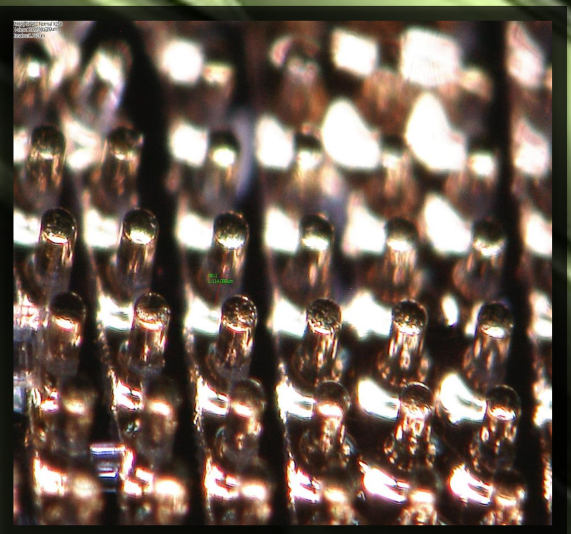
Introduction

SDSU, SWC and SDCC united under the CSNE Program.

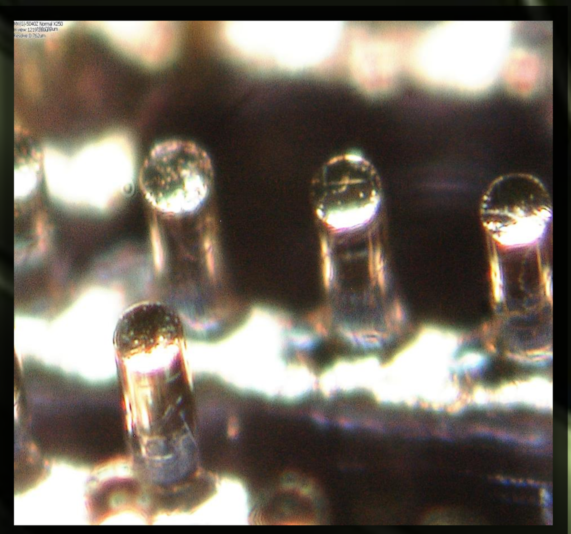
•SDSU is one of the premier research institutions in San Diego. Recently, the NSF funded the ERC for Sensorimotor Neural Engineering (CSNE) at UW, MIT and SDSU. The program's overall goal is to determine how to extract and effectively use neural signals from the human brain. One of the applications is developing prosthetics which directly interface with the brain. Our group was involved in three distinct but related projects: 1) Developing flexible electrodes that can be implanted on the surface of the brain (NeuroMEMS), 2) Correlating the EMG signals that muscles produce to a computer program that can distinguish what type of movement is being produced (EMG), and 3) manipulating nickel titanium (NiTi) to form 3D structures to interface with the brain (NiTi).

Methods

•Project 1) NeuroMEMS: Create an electrode array with a common process called photolithography in SDSU's clean room. Make the electrode array flexible by creating the structure on a base of flexible PDMS. Make the pillars and traces electrically conductive by either gold sputtering, mixing silver nano particles, or pyrolysis.



Electrode array with PDMS, electrodes, traces, and sputtered gold. Taken with the HIROX microscope.



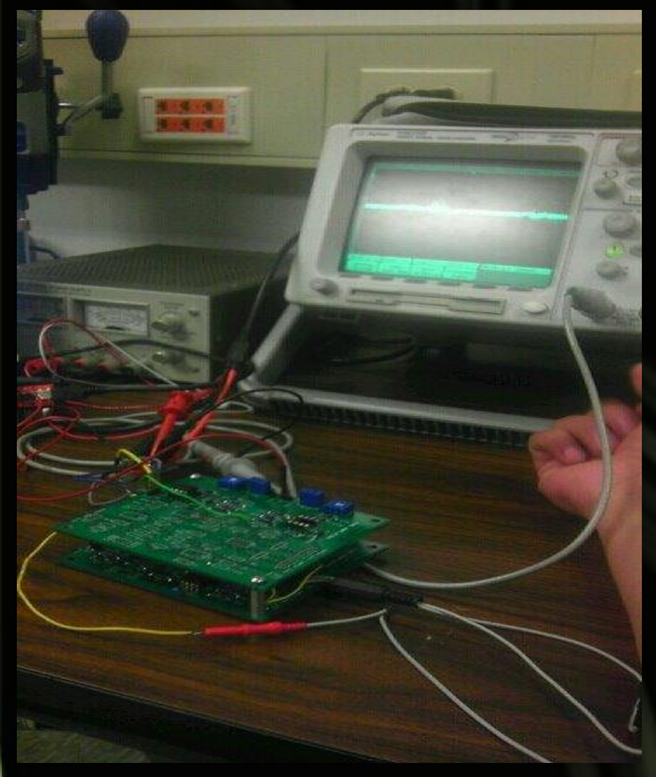
Zoomed in shot of the electrodes. Taken with the HIROX microscope.

•Project 1) NeuroMEMS: Process: Clean a SiO_2 wafer with acetone, IPA, and water. Create PDMS and centrifuge out the air bubbles. Spin coat the PDMS onto the wafer. Cure the PDMS wafer on a hot plate. Plasma etch the PDMS to ensure bonding to SU-8. Spin coat on the photosensitive SU-8 and pre-bake to cure. Expose the chip to UV light through a mask. Post bake. Develop to wash away the non-exposed areas of the SU-8. Repeat SU-8 procedure with different masks to make more layers with traces. Make pillars and traces conductive.

Methods (continued)

Spin coating SU-8 over a plasma etched PDMS SiO_2 wafer.

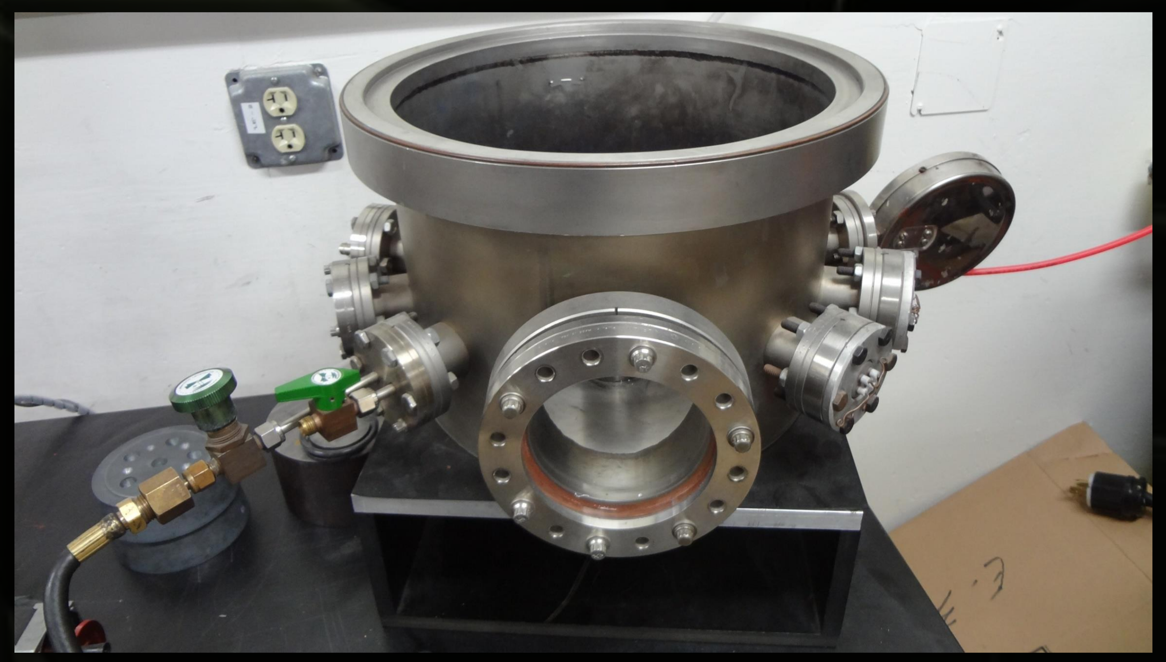
•Project 2) EMG: Signals were detected with electrodes that were placed in the forearm and amplified to a range of ~2mVpp to 3.3 Vpp with the EMG (Electromyograph) Amplifier circuit board to be able to help classify the signals in a more readable range. Many open and closed hand movement samples were collected using different fingers at a time to be able to teach the program to classify with an accuracy that was in a range of 98% or greater the fingers that were being used to make the open and close movement.



Taking EMG signals from the arm.

Collect data wirelessly from USB through MATLAB code. Collect the data, parse data, graph data.

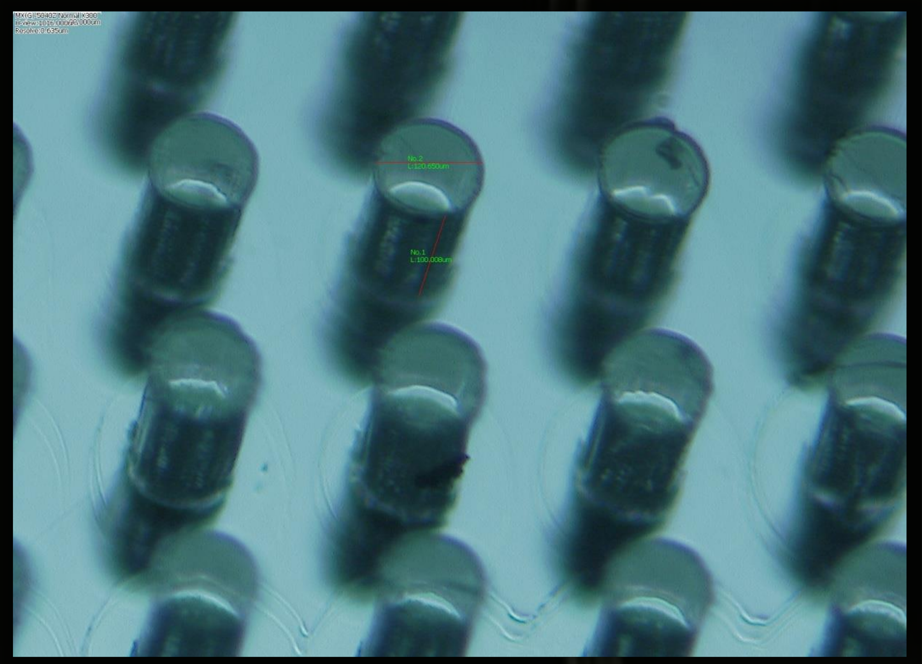
•Project 3) NiTi: Suspend a sample of NiTi in a compressed tubular chamber filled with pure argon gas. The amount of argon gas required is predicted by Bernoulli's equations and modeled in COMSOL. Gas is then pumped into the chamber through a microporous material to remove oxygen and other miasmas. 3D textures are then created in the NiTi by pulsating microjets on the surface.



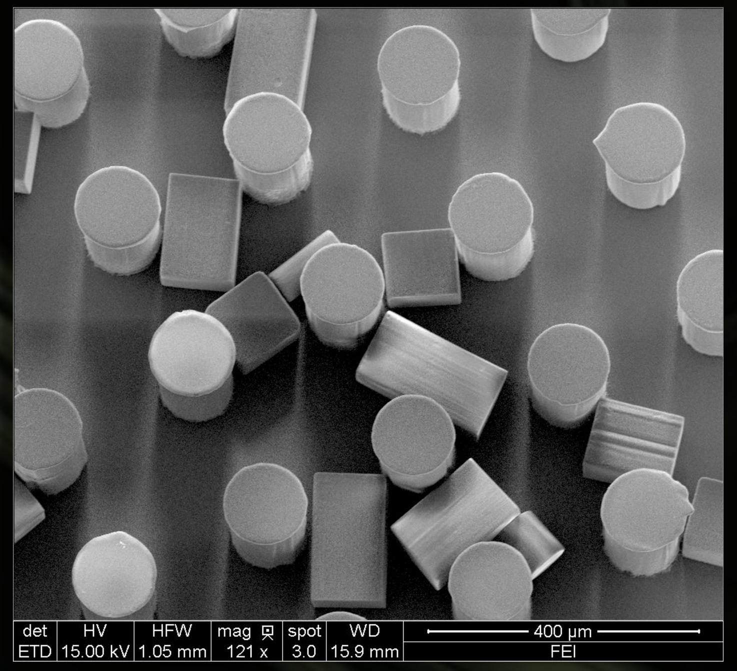
Spark Plasma Sintering chamber, used for heating and fusion of materials

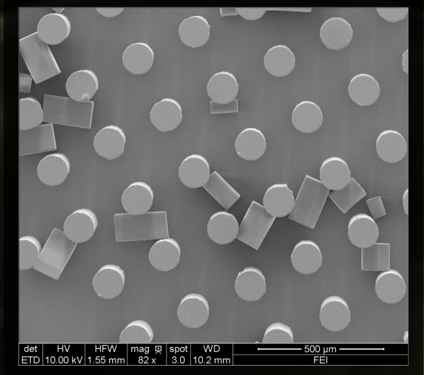
Results

•Project 1) NeuroMEMS: Able to create a flexible electrode array with pillars around 100 micron tall. Successfully sputtered gold onto a thin layer of exposed SU-8 and developed to create traces and pillars.



Electrode array with PDMS and SU-8. No traces or gold sputtering. Pillar height of 100.0 micron and width of 120.7 micron. Taken with the HIROX microscope at X300 zoom.

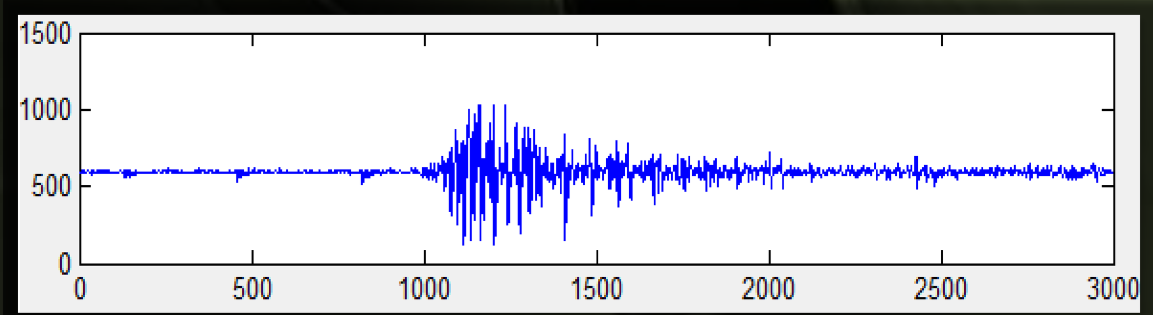




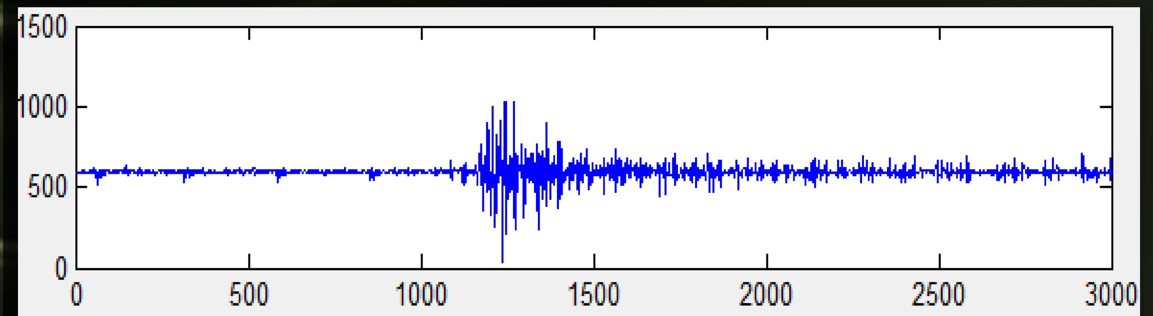
Botched electrode array (left and bottom photos)

Underexposed, washed away pillars scattered across. Taken with SDSU's scanning electron microscope (SEM).

•Project 2) EMG: The sample data that was collected using the EMG oscilloscope. The data was then transferred to a matlab program via the EMG Amplifier circuit board. The GUI created by the matlab program was used to help teach the system how the closed and open movements signals "looked". The program was successfully taught to classify with an accuracy of 98% to detect if the data corresponded to a performance of a close or open movement by the fingers of the hand.



Sample of Close Finger Movement



Sample of Open Finger Movement

•Project 3) NiTi: No results at this time.

Conclusion

•This poster was a collaboration between undergraduate students attending different schools, contributing their research to the main goal which is to be able to develop a prosthetic limb that can be controlled by just the thoughts of the user.

- •Project 1) NeuroMEMS: Frank and Jade chemically develop flexible electrodes that can be inserted on the brain. These electrodes would be able to detect and communicate brain signals and transmit them to a prosthetic limb.
- •Project 2) EMG: Marc and William contributed to the research by classifying movements that would be wirelessly sent to a prosthetic arm by the chip in the brain. This was done by correlating many different movements to certain wavelengths using EMG signals with the use of the MATLAB computer program. This would enable a person using a prosthetic arm to perform more natural and complicated movements with higher accuracy just by thinking about the movement(s).
- •Project 3) NiTi: Jonathan physically manipulated nickel titanium to create a neural interface which could interpret neural activity.

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