Engineering a Better Brain Electrode

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This project aims to replace existing brain electrodes that are failing in chronic use. Brain electrodes have many important applications including the treatment of Parkinson's Disease and brain control of prosthetic limbs. Electrode failure is predominantly caused by extremely stiff electrodes triggering an inflammatory response in the soft neural tissue. The design goal to combat this problem is to engineer a conductive polymer with its glass transition temperature (Tg) in the range of 28-37°C. This temperature range creates a stiff electrode during surgical implantation, which is needed for precise placement, that subsequently softens to a flexible electrode once inside the body, which could prevent the inflammatory response that causes electrode failure. The Tg was engineered by varying the ratio of a short chain thiol to a long chain thiol in the polymer composition. Dynamic mechanical analysis was performed on polymer films of various ratios to find each ratio's corresponding Tg. The best-fit curve was obtained from the graph of Tg vs. mole fraction and used to find the ratio needed to achieve a Tg within the desired range. Once the correct formulation was found, the polymer was made conductive by adding carbon black prior to curing. Electrode strips, wires, and films were fabricated, and the polymer's resistivity was determined from sheet resistance measurements as well as testing the electrode strips in a circuit. The Tg was successfully located around the target range with an average Tg of 28.9°C. The electrode was experimentally confirmed to be conductive. The results suggest that this new material has potential for being used clinically as a brain electrode to help people suffering from Parkinson's Disease, paralysis, and many other life-altering conditions.

Awards Won:

Fourth Award of $500