PLATFORM PRESENTATION ? **NO (Poster only)**
Topic Area – Materials and Devices

Flexible Carbon Based Technologies for Measurement of Mechanical Strains in Neural Prostheses

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The aim of this work is to quantify and alleviate mechanically-induced impairment of electrical function of neurons in order to improve the efficacy of implantable neural prosthetics. We present microfabricated carbon-based strain sensors supported by a flexible substrate that enable *in vivo* measurement of stresses imposed on neural tissues.

We have investigated carbon thick films as piezoresistive elements in polymer substrates. The advantages of carbon thick films include the relative ease of use, integration with established microfabrication techniques and significantly lower cost when compared to traditional metal thin film processing. Furthermore, unlike semiconductor strain sensitive materials, carbon patterns are readily microfabricated on flexible polymer substrates that provide better mechanical-matching to tissue than rigid planar substrates.

We micropatterned high resistance carbon paste (Dupont 7082) by screen printing. Pattern transfer was successfully performed on a variety of substrate materials such as polydimethysiloxane (PDMS), Parylene and silicon. Carbon films (15μm thick) exhibited an average resistivity of 1.5 ohm·cm, which is several orders of magnitude greater than metals, indicating that metal leads to the high resistance carbon sensors will contribute negligible resistance. Furthermore, this simplifies the design of carbon sensing elements obviating the need for serpentine structures usually required by thin film metal sensors to achieve appreciable resistances. Thus, carbon-based sensors occupy a smaller footprint.

Tensile tests were conducted on carbon sensing elements embedded in PDMS. Samples were fabricated with unstrained resistances ranging from 5 Kohm to 48 Kohm. Over 10 μm of elongation, the observed resistance change was linear. These tests yielded a gauge factor of approximately 2 which is on par with thin film metal strain gauges. Strains on the order 0.01% were easily measurable. For comparison, neural tissue such as retina and brain tissue have been shown to withstand as much as 10 % strain with linear elastic behavior.

These results support the use of carbon thick film pastes as a viable piezoresistive material for the measurement of strains in neural tissues. Experiments are underway in which mechanical stresses imposed by a flexible microelectronic prosthesis on retina will be quantified using these devices. Arrays of micro strain sensors will be used so that stress contours can be obtained. These results will guide the development of better surgical implantation techniques and design modifications to epiretinal electrode arrays to minimize mechanical damage.

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