Improving Neural Implant Biocompatibility via Biomimetic Surface Design

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Neural prosthesis are devices used to restore, replace or bypass the lost neurological functions due to diseases or injuries. One of the key components of such a system is a micro-fabricated neural electrode array, placed in the nervous system to directly interface with neurons. Current arrays experience chronic failure due to the inflammatory tissue responses characterized by neuronal loss and glial scarring around the implant. Several biomimetic strategies are being investigated in our lab to improve their biocompatibility and long-term performance within the host brain tissue. The first strategy is immobilization of biomolecules (obtained from brain) onto the implant surface to promote attachment and growth of neurons while suppressing the adsorption of plasma protein and glia. Electrodeposition of conductive polymers are being used to modify the conductive electrode area while covalent coupling is used for modifying the insulating part of the surface. These modifications have been characterized *in vivo* and showed improved neuronal health and reduced reactive glial response around the implant. Secondly, a on-command release coating that can actively deliver anti-inflammatory or neuroprotective drugs is being developed. This system utilizes the electroactivity of conductive polymers that can load ionic molecules and release them upon electrical stimuli. A number of drug molecules have been incorporated in the polymer coating and electrical stimuli can trigger the drug release repeatedly. More importantly, we have shown that the drugs remain active after release and can turn on (or off) neurons or reduce the proliferation of glial cells respectively. This command driven release may be combined with a real time monitoring system so that once an onset of tissue inflammation is detected, an electrical stimulus will be given to trigger the release of the drug at a controlled dose. Other strategies such as cytokine sensing and neural stem cell seeding on the device will be briefly introduced. The ultimate solution may be a combination of multiple approaches.