High-density Optoelectrical Neural Interfaces: Micromanufacturing and Packaging

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Understanding how neural circuits in the brain mediate our behavior and how their dysfunction leads to brain disorders and mental illnesses calls for developing multimodal methods to record and stimulate neural activity in the brain with high spatiotemporal resolution. We have been working on developing compact high-density opto-electrical neural interfaces on flexible substrates to enable bi-directional (read/write) interfacing with the brain for long-term chronic studies. Through a series of device design innovations, we have developed very high-density neural probes on biocompatible polymer substrates for electrophysiological recording and optical stimulation in rodents and non-human primates.

One of the challenges of optical techniques for structural and functional recording in the brain is the scattering and absorption of light, limiting light-based methods to superficial layers of the tissue. To overcome this challenge, implantable photonic waveguides such as optical fibers or graded-index (GRIN) lenses have been used. The prohibitive size and rigidity of optical implants cause damage to the brain tissue and vasculature. In this talk, I will discuss our research on developing next generation optoelectrical neural interfaces based on a novel compact flexible photonic platform using biocompatible polymers, Parylene C and PDMS, for light delivery into the tissue in a minimally-invasive way. This photonic platform can be monolithically integrated with implantable electrical neural probes. The details of micromanufacturing and packaging of these neural interfaces will be presented.

BIOGRAPHY

Maysam Chamanzar is an assistant professor in the Department of Electrical and Computer Engineering and the Department of Biomedical Engineering at Carnegie Mellon University. His active areas of research are at the interface of photonics, bioMEMs, and neuroscience. Using basic principles of physics and advanced engineering techniques, Chamanzar’s group is designing and implementing novel devices and methods to address outstanding needs in biology and medicine. His main application areas of interest are neuroscience and biophotonics. His research on neuroengineering includes developing next generation multimodal (acousto-opto-electrical) neural interfaces to understand the neural basis of brain function and realize functional brain-machine interfaces. The biophotonics front is focused on developing efficient hybrid photonic-plasmonic-fluidic on-chip systems for point of care diagnostics, environmental monitoring, imaging, and spectroscopy. The scope of research encompasses theoretical design and simulation, fabrication and packaging, experimental benchtop characterization, as well as in vivo, in vitro, and ex vivo tests on biological systems.