23: Mechanically compliant devices for long-term peripheral neural interfaces

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ABSTRACT

Interfacing neural tissue to external electrical devices has the potential to revolutionize prosthetics by restoring lost functionality to deficient organs and systems. As such, reliable neural interfaces are a longstanding goal of basic and applied neuroscientific research. Devices that chronically stimulate brain or nerve tissue have existed for several decades in the form of various electrical stimulators – for example, in technologies like deep brain stimulation or cochlear implants. However, devices, capable of long-term recording of neural signals, are very far from routine even in a research environment.

A significant technical challenge that prevents the long-term stability of implanted neural interfaces, is the formation of a so-called glial scar. Glial cells are support cell populations in the brain and neural tissue, which perform various functions, among which are recognizing and encapsulating foreign bodies in scar tissue. Recently, it has been identified that the severity of this process can be strongly attenuated, by using implants which match the stiffness of the surrounding brain tissue (G'~1 kPa)[1].

We are currently developing a microchannel PDMS-based implant that matches the G' of neural tissue. Electrical interfacing would use organic electrochemical transistors, patterned using a combination of photolithography and femtoliter printing. The use of a microchannel to insulate the nerve from its surroundings[2], an active transistor at the recording site[3] have each been shown to increase signal-to-noise ratio in recording. A soft implant body has promoted biontegration in animal models[4] We speculate that a combination of those features would further improve quality and longevity of recordings.

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BIOGRAPHY

Ivan Dimov is a NanoDTC PhD student, working in the labs of Dr. Kristian Franze in Physiology, Development and Neuroscience, and of Prof. Henning Sirringhaus in Optoelectronics. His current project is on fabricating a stretchable implant for chronic recording and stimulation from peripheral nerves. Previously, he obtained an MChem in Chemistry from Oxford, having done his final research year in the lab of Prof. Hagan Bayley, working on printed networks of droplet interface bilayers.