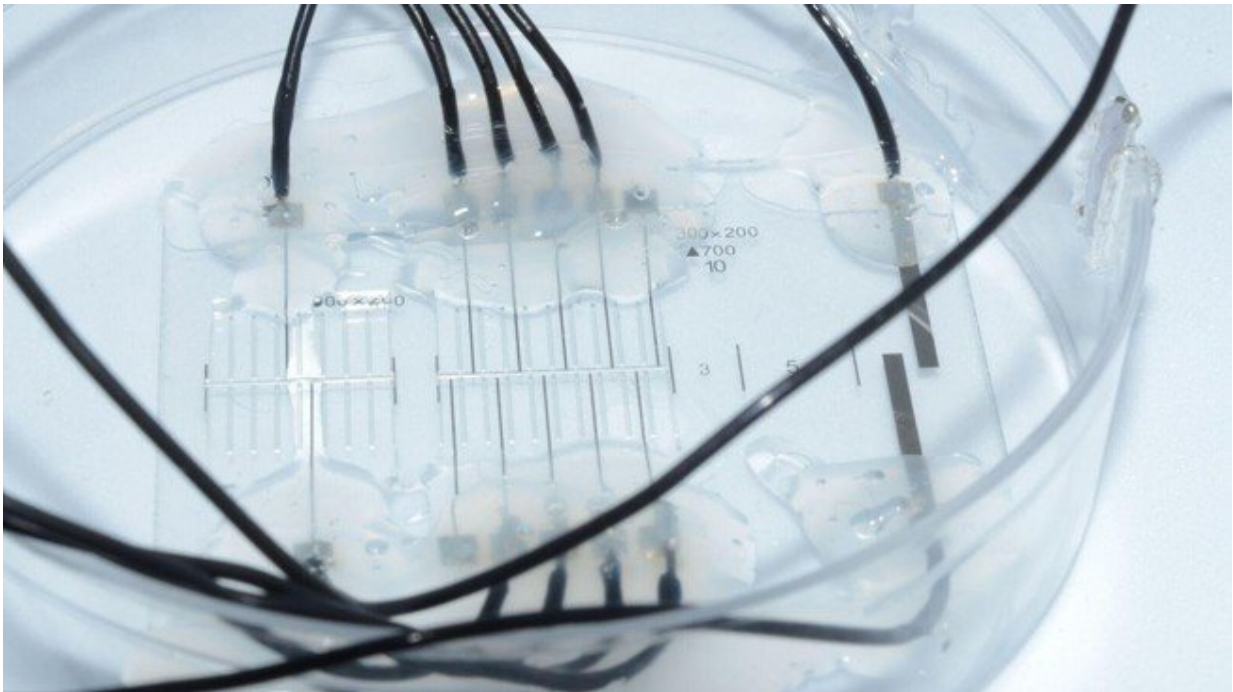


Nerve-on-a-chip platform makes neuroprosthetics more effective

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The "nerve-on-a-chip" platform paves the way to using chips to improve neuroprosthetic designs. Credit: Florent-Valéry Cohen

EPFL scientists have developed a miniaturized electronic platform for the stimulation and recording of peripheral nerve fibers on a chip. By modulating and rapidly recording nerve activity with a high signal-to-noise ratio, the platform paves the way to using chips to improve neuroprosthetic designs.

Neuroprosthetics – implants containing multi-contact electrodes that can substitute certain [nerve](#) functionalities – have the potential to work wonders. They may be able to restore amputees' sense of touch, help the paralyzed walk again by stimulating their spinal cords and silence the [nerve activity](#) of people suffering from chronic pain. Stimulating nerves at the right place and the right time is essential for implementing effective treatments, but still a challenge due to implants' inability to record [neural activity](#) precisely. "Our brain sends and receives millions of [nerve impulses](#), but we typically implant only about a dozen electrodes in patients. This type of interface often doesn't have the resolution necessary to match the complex patterns of information exchange in a patient's nervous system," says Sandra Gribi, a Ph.D. student at the Bertarelli Foundation Chair in Neuroprosthetic Technology.

Replicating – and improving – how neuroprosthetics work

Scientists at the lab run by Dr. Stéphanie Lacour, a professor at EPFL's School of Engineering, have developed a nerve-on-a-chip platform that can stimulate and record from explanted nerve fibers, just as an implanted neuroprosthetic would. Their platform contains microchannels embedded with electrodes and explanted nerve fibers faithfully replicate the architecture, maturity and functioning of in vivo tissue.

The scientists tested their platform on explanted nerve fibers from rats' spinal cords, trying out various strategies for stimulating and inhibiting neural [activity](#). "In vitro tests are usually carried out on neuron cultures in dishes. But these cultures don't replicate the diversity of neurons, like their different types and diameters, that you would find in vivo. Resulting [nerve cells](#)' properties are changed. What's more, the extracellular microelectrode arrays that some scientists use generally can't record all the activity of a single nerve cell in a culture," says Gribi.

The nerve-on-a-chip platform developed at EPFL can be manufactured in a clean room in two days and is able to rapidly record hundreds of nerve responses with a high signal-to-noise ratio. However, what really sets it apart is that it can record the activity of individual nerve cells. The research has been published in *Nature Communications*.

Inhibiting the activity of specific neurons

The scientists used their platform to test a photothermic method for inhibiting neural activity. "Neural inhibition could be a way to treat chronic pain like the phantom limb pain that appears after an arm or leg has been amputated, or neuropathic pain," says Lacour.

The scientists deposited a photothermic semiconducting polymer, called P3HT:PCBM, on some of the chip's electrodes. "The polymer heats up when subject to light. Thanks to the sensitivity of our electrodes, we were able to measure a difference in activity between the various explanted [nerve fibers](#). More specifically, the activity of the thinnest fibers was dominantly blocked," says Gribi. And it's precisely those thin fibers that are nociceptors – the sensory neurons that cause pain. The next step will be to use the polymer in an implant placed around a nerve to study the inhibiting effect in vivo.

Distinguishing between sensory and motor nerve fibers

The scientists also used their [platform](#) to improve the geometry and position of recording electrodes, in order to develop an implant that can regenerate peripheral nerves. By running the measured neural data through a robust algorithm, they will be able to calculate the speed and direction of nerve impulse propagation – and therefore determine

whether a given impulse comes from a sensory or motor nerve. "That will enable engineers to develop bidirectional, selective implants allowing for more natural control of artificial limbs such as prosthetic hands," says Lacour.

More information: Sandra Gribi et al. A microfabricated nerve-on-a-chip platform for rapid assessment of neural conduction in explanted peripheral nerve fibers, *Nature Communications* (2018). [DOI: 10.1038/s41467-018-06895-7](https://doi.org/10.1038/s41467-018-06895-7)

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