favours labyrinthine wrinkled patterns whereas the outer region (with positive Gaussian curvature) favours hexagonal wrinkles (as shown in the Supplementary Information of ref. 2). These results should be followed up by careful experimentation, especially on surfaces with more complex curvature, which can show far richer behaviour than the spherical geometry considered by Dunkel and colleagues. In fact, recent experiments on twisted ribbons[9] and on elastic sheets adsorbed onto fluid droplets[10] show a variety of wrinkle patterns that can be compared quantitatively to theory.

These experiments also show that there are limits to using curvature to control wrinkles: in the twisted ribbons, wrinkles can give way to sharper features reminiscent of folds[9], and the sheets on fluid droplets can display features better described as crumples[10]. It remains to be seen how well Dunkel and colleagues' theory would capture these. ❐

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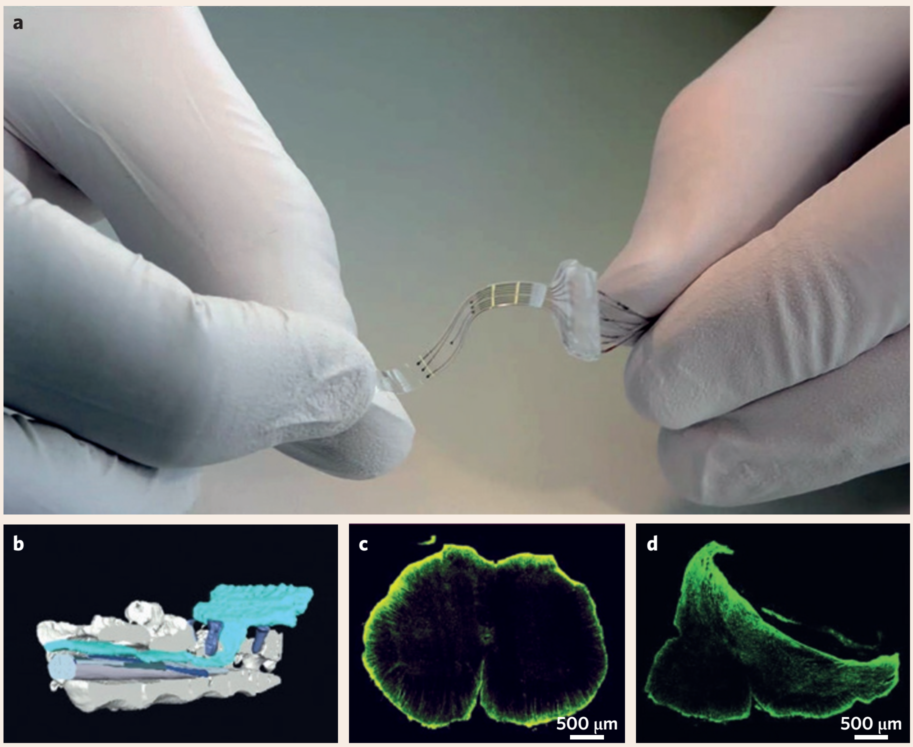
BIOELECTRONICS

Soft implants for long-term use

The first hint of how electricity can be used to interact with the body's nervous system came from Luigi Galvani, who discovered in 1780 that the leg of a dead frog could be moved by applying an electric current to the leg's nerves. Since then, scientists have learned how to record the activity of neural cells with electrodes and stimulate nervous tissues with electrical pulses, which has led to the realization of modern biomedical devices such as pacemakers and cochlear implants. These days, the challenge is to develop implantable neural prostheses that can repair damage in the central nervous system — brain and spinal cord — on a long-term basis without causing tissue reactions such as inflammation or scarring. One main hurdle relates to the high stiffness of the typical materials used for implants when compared with the more compliant soft biological tissues. One solution is to use flexible electronics, as recently demonstrated by Stéphanie Lacour, Grégoire Courtine and colleagues (*Science* **347,** 159–163; 2015).



The researchers fabricated a transparent and ultrathin silicone layer with embedded gold interconnects, platinum–silicone pads for neural stimulation and recording, and a microfluidic channel for drug delivery (panel **a**), with mechanical properties that match those of the dura mater — the membrane protecting the brain and the spinal cord. After implantation, the device (shown in light blue in the three-dimensional rendering of panel **b**) conformed to the contour of a rat's spinal cord (panel **b**; dark grey). After 6 weeks from insertion, the researchers observed that the soft implant altered the cross-section of the spinal cord only minimally (panel **c**) whereas the stiffer device caused the cross-section to severely flatten (panel **d**). Additionally, the immune response to the soft device was more moderate, as indicated by the lower concentration of neuroinflammatory cells.

More significantly, Lacour and colleagues tested the effectiveness of the devices in bypassing lesions of the central nervous system. They inserted the 'electronic dura mater' (as they called the device) at the lesion site of the spinal cord of an adult rat with permanently paralysed legs. The platinum–silicone pads electrically stimulated the locomotor nerves below the injury while a chemical treatment was locally delivered through the microfluidic channel. The combination of both stimuli allowed the rat to move its legs again. With further work, these implants could be made autonomous, which will need more complex electronic circuitry and embedded microfluidic pumps. From Galvani's dead frog to today's walking rat, progress in bioelectronics is posed to impress.

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