BIOELECTRONICS

Printing bionic ears

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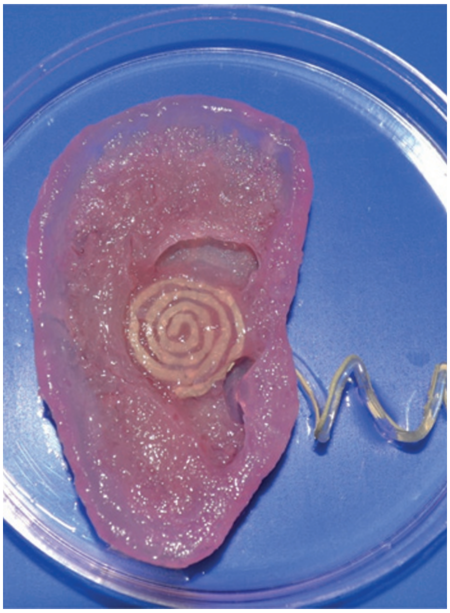

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By combining biological tissue with functional electronics, bionic body parts can be created that could potentially offer superior capabilities to their natural counterparts. Tissue and electronics have previously been coupled by using planar electronic devices that can conform to the surface of natural tissue and such devices have, for example, been used to map brain activity. Michael McAlpine and colleagues at Princeton University and John Hopkins University have now merged the two concepts by using a 3D printer to build a bionic ear.

The researchers first created a computer-aided design (CAD) drawing of an ear that had an integrated circular coil antenna connected to cochlea-shaped electrodes. An alginate hydrogel matrix seeded with chondrocyte cells was used to make the shape of the ear, and a conducting polymer infused with silver nanoparticles was used to make the antenna and the electrodes. The materials are fed into the 3D printer, which uses slices of the CAD model to build the structure layer-by-layer. The cells in the hydrogel matrix can then be used to grow cartilage tissue in the shape of the hydrogel scaffold by immersing the printed ear in chondrocyte culture media.

The resulting bionic ears can sense electromagnetic signals in the radio frequency range, and a pair of ears can listen to stereo audio music. *OV*

FLUORESCENCE THERMOMETRY

Single spins feel the heat

Proc. Natl Acad. Sci. USA **110,** 8417–8421 (2013)

In fluorescence thermometry, temperature is measured by monitoring the variation in the intensity of light emitted by a fluorophore. Nitrogen–vacancy (NV) centres in diamond nanocrystals — defects that consist of a nitrogen impurity linked to a carbon vacancy — are promising for fluorescence thermometry, particularly in biological environments, because of the small size of the crystals and the relative inertness of diamond.

David Awschalom and colleagues at the University of California, Santa Barbara, Ames Laboratory and the University of Chicago have now shown that the electron spin associated with a NV centre can be used to achieve a record sensitivity, seven times better than previously attained. The long coherence time of NV centres allows coherent control of the electron spin state population through excitation with optical pulses. This results in oscillations of the fluorescence intensity with a frequency that is dependent on temperature.

With the approach, the researchers are able to achieve a sensitivity approaching 10 mK $Hz^{-1/2}$ at room temperature, which suggests that it could be useful in a variety of biological settings. *FP*

MAGNETIC NANOSTRUCTURES

Lighting up skyrmions

Phys. Rev. Lett. **110,** 177205 (2013)

Magnetic skyrmions are topologically protected spin nanostructures that could be used to create novel magnetic information storage devices. To stabilize the structures, applied magnetic fields are required, but this limits their potential applications. Marco Finazzi and colleagues have now shown that skyrmion-like magnetic configurations can be generated in a thin ferromagnetic film by using single ultrafast optical laser pulses.

The researchers — who are based at the Politecnico di Milano, Radboud University Nijmegen, Nihon University and the University of Tokyo — generate single skyrmions in 20-nm-thick TbFeCo films using single laser pulses with a width of 150 fs and a wavelength of 800 nm. The magnetic nanostructures are observed by Faraday rotation, which maps the out-of-plane magnetization component. The lateral dimensions of the structures are in the range of a few hundred nanometres and can be tuned by changing the laser fluence. Higher laser fluences result in larger and more complex structures, such as annular magnetization configurations, which can be thought of as an anti-skyrmion nested in a skyrmion.

The presence of a finite uniaxial anisotropy in the films is sufficient to stabilize the structures, even in the absence of an external magnetic field. *ED*

NANOCRYSTALS

In a squeeze

Phys. Rev. Lett. **110,** 185901 (2013)

Solid objects cannot usually get through a hole smaller than itself without modifying its physical state. Sinisa Coh and colleagues at the University of California, Berkeley and Lawrence Berkeley National Laboratory have now discovered an intriguing exception to this where an iron nanocrystal that completely fills a carbon nanotube with an inner diameter of 20 nm can squeeze through a 5-nm constriction without melting and recrystallizing on the other side.

The researchers examined the movement of the nanocrystal through the nanotube under the application of an electric current with the help of an *in situ* transmission electron microscope. Electron imaging and diffraction measurements showed that while passing through the constriction the nanocrystal remained essentially solid and crystalline. To explain these observations, the team carried out kinetic Monte Carlo simulations, which assumed that each iron atom experiences an electromigration force that is proportional to the current applied to the carbon nanotube. It turns out that only the atoms in contact with the nanotube move in the direction of the current; the atoms in the bulk remain stationary. According to the simulations, therefore, the surface atoms constantly move forward. The back edge of the nanoparticle disassembles and then reassembles at the front edge. This means that the front edge can adjust its size to match the constriction and can therefore lead the whole nanoparticle through without losing its crystallinity. *AM*

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