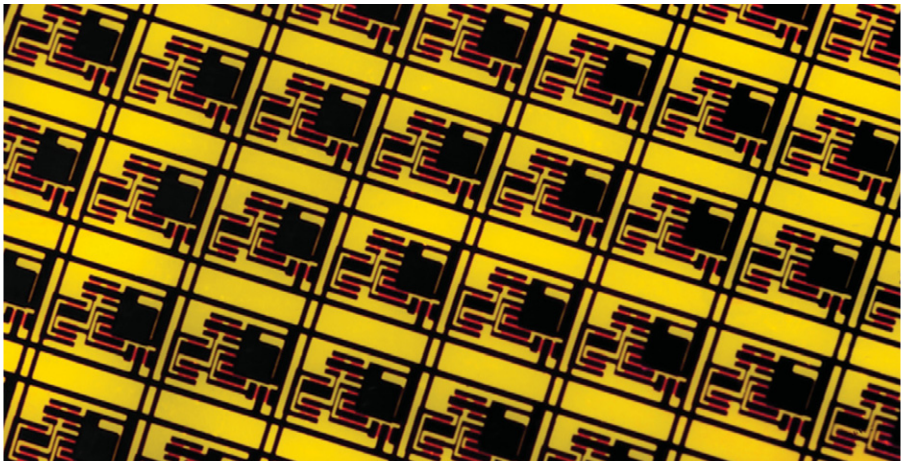
Stretchable electronics that map the heart

ELECTRONIC MATERIALS

Scientists have developed a new electronic device that allows circuits to bend, stretch and twist, and that could be used in places where normal electronics would not work, such as in the heart or brain. This innovative device, capable of directly sensing and controlling activity in animal tissue, can produce high-density maps of the electrical activity produced by a beating heart, with better resolution and speed than that of conventional cardiac monitoring technology. Published in the journal Science Translational Medicine (Viventi et al, DOI: 10.1126/scitranslmed.3000738), the research demonstrates silicon nanomembrane transistors configured to record electrical activity directly from the curved, wet surface of a beating porcine heart in vivo. Also operating when immersed in the body's fluids, this minimally invasive medical technology could allow for the localizing and treatment of abnormal heart rhythms, such as arrythmias or in epilepsy, as well as in new flexible sensors, transmitters and photovoltaic and microfluidic devices.



Silicon device.

The research team, from Northwestern University, the University of Illinois at Urbana-Champaign and the University of Pennsylvania, have helped to open up the body's complex electrical networks to examination for the first time, paving the way for more effective implantable medical devices and treatments.

Based on a range of tiny circuit elements connected by metal wire pop-up bridges, the technology allows the wires to pop up when bent or stretched, allowing circuits to be placed on a curved surface. As one of the team leaders, John Rogers, points out, the team were interested "in creating electronics with the performance of conventional, wafer-based devices, but with the mechanical properties of a rubber band."

With the electronics currently used for heart monitoring being flat and rigid, this device, with its wavy mesh design, can wrap around irregular and curved surfaces, and is thin and stretchable enough to bring electronic circuits right to the tissue with more contact points, which means improved data.

The device uses 288 contact points, rather than the usual 5–10 of standard clinical systems, and more than 2,000 transistors positioned closely together. It is this large amount of contact points that gives it an advantage over current medical electronics that fail when any significant bending or stretching occurs.

The team hope that this type of electronics will provide new applications not based on current technologies, ranging from advanced surgical devices, to implants, to wearable monitors. For cardiac monitoring, they are working on devices that can deploy on balloon catheters, and other applications could include similar systems that monitor the brain using a type of brain–computer interface, ultimately in fully implantable forms for long-term use, as well as in bio-inspired device design.

Laurie Donaldson

New shape ceramics

ELECTRONIC MATERIALS

Researchers from North Carolina State University have developed a new way to shape ceramics using a modest electric field, making the process significantly more energy efficient. The process should result in significant cost savings for ceramics manufacturing over traditional manufacturing methods. [Conrad and Yang, *Philosophical Mag.* (2010) **9**, 1141.

Ceramics make up significant components of an array of products, including insulators, spark plugs, fuel cells, body armor, gas turbines, nuclear rods, high temperature ball bearings, high temperature structural materials and heat shields.

At issue are crystalline defects found in crystalline materials, such as ceramics. "One of these defects is called a grain boundary, which is where crystals with atoms aligned in different directions meet in the material," says Dr. Hans Conrad, emeritus professor of materials science and engineering at NC State and co-author of the study. These boundaries have electrical charges.

"We found that if we apply an electric field to a material, it interacts with the charges at the grain boundaries and makes it easier for the crystals to slide against each other along these boundaries. This makes it much easier to deform the material." In other words, the material becomes superplastic – so a ceramic can be shaped into a desirable form using a small amount of force.

"We've found that you can bring the level of force needed to deform the ceramic material down to essentially zero, if a modest field is applied," Conrad says. "We're talking between 25 and 200 volts per centimeter, so the electricity from a conventional wall socket would be adequate for some applications."

These findings mean that manufacturers who make anything out of ceramics will be able to do so using less energy. "It will make manufacturing processes more cost-effective and decrease related pollution," Conrad says. "And these findings also hold promise for use in the development of new ceramic body armor."

Conrad is planning to do additional work using this approach to fabricate ceramic body armor with better properties at a lower cost.

Jonathan Agbenyega