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>
> Jack Ma, electrical engineer, University of Wisconsin

Technology spotlight

Silicon stretches into shape

Flexible electronic devices made from organic materials may soon make it to market, but it appears that the high-performance mainstay of the electronics industry could be given a new lease of life by materials scientists. Silicon could, the researchers claim, be used in integrated circuits that stretch and wrap around complex shapes such as spheres, body parts and aircraft wings, and operate during extreme deformation.

Silicon is normally thought of as a brittle crystalline material. But in 2005 physical chemist John Rogers and his research group at the University of Illinois at Urbana-Champaign introduced the concept of one-dimensional, concertina-like geometries of ultra-thin, single-crystal silicon strips. With these structures the researchers created simple components such as p-n junction diodes and transistors, but there was at the time no way to combine them into circuits and systems.

Rogers and his group, together with collaborators at Sungkyunkwan University in Korea, Northwestern University in Illinois, US, and the Institute of High Performance Computing in Singapore, have now taken this a step further and extended the concept to two dimensions. 'Now, through advanced designs and new fabrication strategies, we can build ultra-thin, foldable circuit sheets,' says Rogers. 'These, when bonded to rubber, can adopt complex, 2-D wavy patterns that provide full, 2-D stretchability at the level of complete, fully integrated circuits.'

To create flexible integrated circuits the researchers first apply a sacrificial layer of polymer to a rigid substrate, and on top of this deposit a very thin plastic coating. Circuit components are then crafted using conventional techniques for planar device fabrication, along with printing methods for integrating aligned arrays of single-crystal silicon nanoribbons as the semiconductor.

Following this the polymer layer is washed away and the plastic coating and circuit are bonded to a piece of pre-strained silicone rubber. When the strain is released and the rubber returns to its initial shape, compressive stresses are set up in the circuit sheet which lead to a complex pattern of buckling. This creates a geometry that allows the circuit to be folded or stretched in different directions.

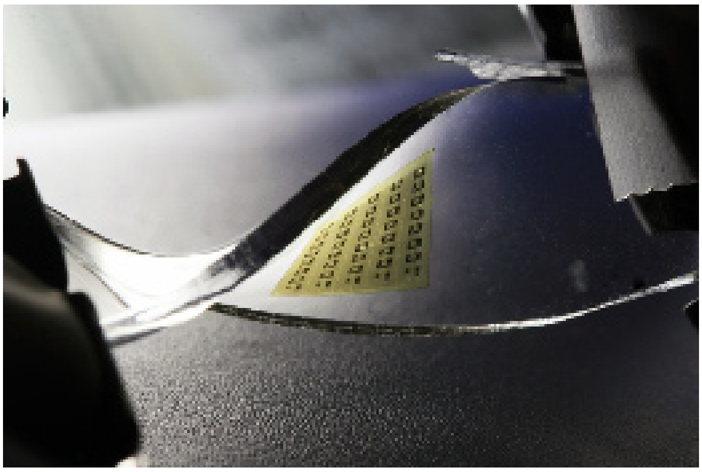
'These results represent a realistic pathway to stretchable electronics with excellent performance and nearly arbitrary levels of complexity,' says Rogers.

Jack Ma, an electrical engineer at the University of Wisconsin, is another researcher active in the field of flexible electronics. 'A completely integrated and bendable, up to being foldable, circuit has not been demonstrated before,' he says. 'There are many applications for this new type of circuit and, in some cases, stretchable and foldable integrated circuits may be the only choice.'

This time last year Rogers and the University of Illinois launched a venture-backed start-up to commercialise the research and develop products based on the printing technology used for these systems. The company, Semprius, is currently working on a micro-concentrator photovoltaic product, and has begun discussions on sub-licensing the technology to a group that intends to explore stretchable electronics in the context of biomedical devices.

Rogers explains that in terms of technical maturity Semprius looks a lot like the Dutch firm Polymer Vision did around three or four years ago: 'It's early, but there is some amount of activity.'

Scientists have developed a new form of stretchable silicon integrated circuit that can wrap around complex shapes



Source: Rogers Research Group/University of Illinois