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Self-assembling 3-D IC networks studied

By Nolan Fell
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LONDON — Scientists at Harvard University have developed a technique in which three-dimensional networks build themselves. Led by David Gracias, the five-strong team from the department of chemistry and chemical biology published their work in the Aug. 21 edition of the journal *Science*.

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Most microelectronics manufacturing is essentially a two-dimensional process, with separate integrated circuits stacked to achieve 3-D interconnections. The Harvard team used a structure called a truncated octahedron (TO) with ICs printed on its hexagonal faces, defined on a flexible copper-polyimide sheet using photolithography and etching. LEDs were soldered onto the contact pads, and the copper dots and wires on the square faces of the TO were coated in solder.

The TOs were then placed in a hot, isodense, aqueous potassium bromide (KBr) solution. The pattern of dots and wires was the same in all the TOs. In the KBr solution the dots on one TO connected with those on another, creating serial I/O connections. With a number of TOs connected in this way, the LEDs lighting up demonstrated the integrity of the circuits.

"We used a solder with a very low melting point, 47 degrees Celsius," said Gracias. "Like mercury, solder has a very high surface tension when it melts. If two molten bits of solder meet, they join together. The symmetry and patterns of the dots are engineered so they have to connect in the correct way."

Using different connection structures, Gracias and his team have demonstrated both parallel and serial connectivity. The next step is to create 3-D structures with more complex ICs with elements of digital logic.

'Brain a 3-D net'

Three-dimensional structures offer a number of benefits, including more efficient cooling; it is possible to pump fluid through the assemblies. Self-assembly makes the formation of interconnected elements in deterministic and probabilistic networks possible. The authors suggest it may be possible to generate logical structures such as artificial neural networks using this technique.

"The brain is the best 3-D network," said Gracias. "This technique can build dendritic structures, which are similar to neural networks. But the main application is likely to be producing more efficient electronic devices." Gracias said significant advances in the production of the elements are needed before more complex structures can be built.

Nolan Fell is the technology editor of Electronics Times, EE Times' *sister publication in the United Kingdom.*