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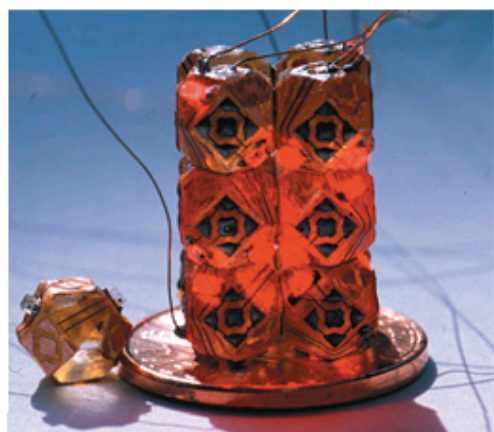


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Self-Assembling 3-D Electronics

[Bethany Halford](#)



David Gracias/Harvard U (left), Langmuir (right)

Ten years ago, self-assembling microelectronic circuits (left) had to be painstakingly made by hand. Today, machine fabrication is possible, thanks to microscale building blocks that self-fold and self-assemble (right).

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Chemistry isn't necessarily the most photogenic of disciplines, but 10 years ago, [George M. Whitesides'](#) group at Harvard University grabbed the chemical community's attention with a picture of a curious electronic device sitting upon a penny. The doodad was a microelectronic device built from small modular components that spontaneously self-assemble into a three-dimensional circuit.

At the time, Whitesides told C&EN that it was too early to commercialize the technology. "That's maybe three to five years away," he predicted. A decade later, the self-assembling microelectronics still have yet to reach their full potential. "People continue to explore it in universities, but it is not something that has reached into real use," Whitesides tells C&EN.

David H. Gracias, who worked on the project as a postdoc in Whitesides' lab, is one of those continuing to push the technology forward. Gracias, now at Johns Hopkins University, has been working to shrink the self-assembling components and automate their laborious production.

So far, Gracias says, he's succeeded on both fronts. His lab has made modular building blocks on the 100-nm scale and produced them in a

high-throughput manner. But there are still some stumbling blocks, he notes. High-throughput yields aren't 100% yet, and his group is still grappling with how to route wires and remove heat from the highly interconnected circuits.

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Getting electronics to self-assemble in 3-D is still one of the grand goals of electronics fabrication, Gracias says. He likens current fabrication methods used in the industry to tiling a bathroom floor: "In two dimensions, there are only so many tiles you can put down before you run out of real estate, so people have to make smaller and smaller tiles. If you're able to use three dimensions, you can work with bigger tiles, and you can make highly interconnected circuits."

As for the photogenic doodad that graced the cover of C&EN 10 years ago, Gracias says most of the devices—which were made from painstakingly handcrafted components—are probably in a drawer somewhere at Harvard. He recalls that back when the work was first reported, a friend remarked that the Smithsonian Institution would come looking for the devices someday. "The Smithsonian hasn't come yet," Gracias says, "but I do have one," just in case.

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