Researchers fabricate DNA strands on a reusable chip, fold them into novel nanostructures

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In the emerging field of synthetic biology, engineers use biological building blocks, such as snippets of DNA, to construct novel technologies. One of the key challenges in the field is finding a way to quickly and economically synthesize the desired DNA strands. Now scientists from Duke University have fabricated a reusable DNA chip that may help address this problem by acting as a template from which multiple batches of DNA building blocks can be photocopied. The researchers have used the device to create strands of DNA which they then folded into unique nanoscale structures. They will present their findings at the AVS Symposium, held Oct. 30 – Nov. 4, in Nashville, Tennessee.

Many different methods of DNA synthesis have been developed, but each method has its drawbacks. Bulk DNA synthesis, which makes use of separate columns to house the reactions, can produce large amounts of material, but is costly and limited in the number of different DNA sequences it can create. The Duke researchers, by contrast, used an inkjet printer head to deposit small droplets of chemicals on top of a plastic chip, gradually constructing DNA strands of mixed length and composition on the surface. The team then used a biological photocopying process to harvest the DNA from the chip. To the researchers' surprise, they found they could reuse the chip to harvest multiple batches of DNA. "We found that we had an "immortal" DNA chip in our hands," says Ishtiaq Saaem, a biomedical engineering researcher at Duke and member of the team. "Essentially, we were able to do the biological copying process to release material off the chip tens of times. The process seems to work even using a chip that we made, used, stored in -20C for a while, and brought out and used again."

After releasing the DNA from the chip, the team "cooked" it together with a piece of long viral DNA. "In the cooking process, the viral DNA is stapled into a desired shape by the smaller chip-derived DNA," explains Saaem. One of the team's first examples of DNA origami was a rectangle shape with a triangle attached on one side, which the researchers dubbed a "nano-house." The structure could be used to spatially orient organic and inorganic materials, serve as a scaffold for drug delivery, or act as a nanoscale ruler, Saaem says.

Going forward, the team intends to produce larger DNA structures, while also testing the limit of how often their chip can be reused. In the near-term, the research has applications in the spatial positioning of biomolecules, such as proteins, for research purposes. Long-term, it might even transform information technology: "I would not be surprised if this methodology is used to fabricate the next generation of microprocessors that can push Moore's law even further," Saaem says.

More information: The AVS 58th International Symposium & Exhibition will be held Oct. 30 – Nov. 4 at the Nashville Convention Center.

Presentation BI-MoM10, "DNA Origami from Inkjet Synthesis Produced Strands," is at 11:20 a.m. on Monday, Oct. 31.

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