Multi-micron crisscross structures grown from DNA-origami slats

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Living systems achieve robust self-assembly across a wide range of length scales. In the synthetic realm, nanofabrication strategies such as DNA origami have enabled robust self-assembly of submicron-scale shapes from a multitude of single-stranded components. To achieve greater complexity, subsequent hierarchical joining of origami can be pursued. However, erroneous and missing linkages restrict the number of unique origami that can be practically combined into a single design. We have used crisscross polymerization of DNA-origami slats for fabrication of custom multi-micron shapes with user-defined nanoscale surface patterning [1]. Using a library of ~2000 strands that can be combinatorially assembled to yield DNA-origami slats programmed with diverse single-stranded extensions along their lengths, we realize five-gigadalton structures composed of >1000 uniquely addressable slats with lateral dimensions of ~2 μm (Fig. 1), and periodic structures incorporating >10,000 slats. Robust production of target crisscross structures is enabled through strict control over initiation, rapid growth and minimal premature termination, and highly orthogonal binding specificities. Thus crisscross growth provides a generalizable route for prototyping and scalable production of devices integrating thousands of unique components that each are sophisticated and molecularly precise.

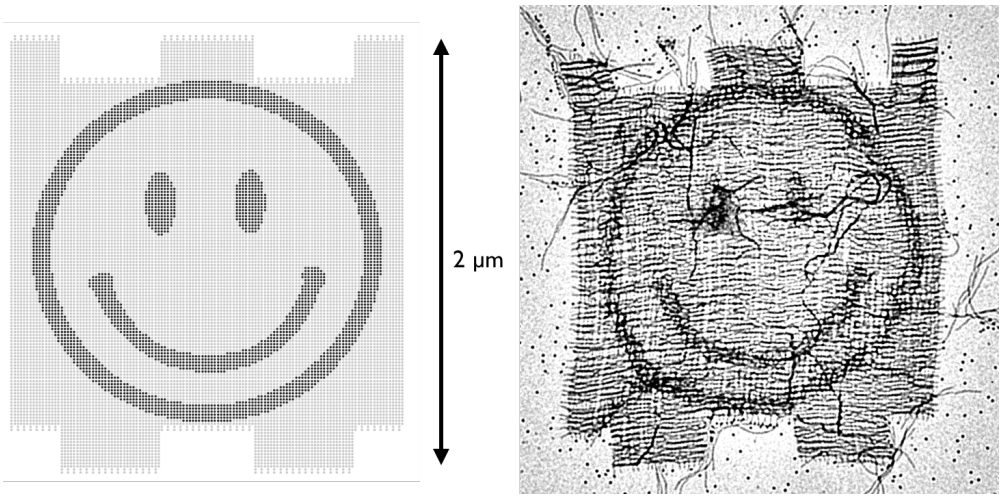

Figure 1. Left, design of a sheet, two microns per side, assembled from one copy each of 1023 unique DNA-origami components. Darker dots indicating sites that were programmed with a handle sequence to bind a DNA-nanocube contrast agent. Right, negative-stain transmission electron micrograph of a sheet.

[1] Wintersinger CM, Minev D, Ershova A, Sasaki HM, Gowri G, Berengut JF, Corea-Dilbert FE, Yin P, Shih WM, Multi-micron crisscross structures from combinatorially assembled DNA-origami slats. *bioRxiv* 2022.01.06.475243