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Programmable disorder in random DNA tilings.

Scaling up the complexity and diversity of synthetic molecular structures will require strategies that exploit the inherent stochasticity of molecular systems in a controlled fashion. Here we demonstrate a framework for programming random DNA tilings and show how to control the properties of global patterns through simple, local rules. We constructed three general forms of planar networks — random loops, mazes and trees — on the surface of self-assembled DNA origami arrays on the micrometre scale with nanometre resolution. Using simple molecular building blocks and robust experimental conditions, we demonstrate control of a wide range of properties of the random networks, including the branching rules, the growth directions, the proximity between adjacent networks and the size distribution. Much as combinatorial approaches for generating random one-dimensional chains of polymers have been used to revolutionize chemical synthesis and the selection of functional nucleic acids, our strategy extends these principles to random two-dimensional networks of molecules and creates new opportunities for fabricating more complex molecular devices organized by DNA nanostructures. (Received July 09, 2017)