2D self-assembly of shape-complementary DNA origamis

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Abstract

Both in biological and synthetic systems, molecular self-assembly is key to acquire specific properties. In nanotechnology in general and in semiconductor industry in particular, there is an ever-increasing need for smaller and more complex features at an ever-lower cost. To address the challenge of patterning at sub-10 nm scale, novel strategies must be envisioned. Among emerging technologies, directed self-assembly (DSA) of materials to create the lithography mask onto the substrate receives a lot of interest due to their theoretical high-resolution and uniformity. By virtue of its inherent small helix diameter (2 nm), DNA can be programmed to self-organize into various 1D, 2D and 3D morphologies at nano-scale resolution. Therefore, DNA is a promising masking material for bottom-up lithography techniques.

Although DNA origamis are limited in size (from tenths to a hundred nanometers), 2D, 3D and high molecular weight objects can be obtained through binding of numerous origamis. To limit defectivity and promoting order, shape-complementarity can be used to do 2D assemblies: DNA nanostructures assemble similarly to how puzzle pieces do. They are thus reversible thanks to ?-? stacking interactions and defects can be avoided or even corrected in-situ. Here, by using these interactions, we aim to reach high quality of 2D organization of DNA units.

We develop new shape-complementary origamis, e.g. squares of 50 by 50 nm in size, for 2D periodic patterns. They have been created on large scales (up to 10 microns), with a high degree of order and little to no defects by optimizing the experimental parameters. The dimensions of the origamis and the patterns have been measured by Aselta SIMPL software, which extracts contours of objects and performs measurements on them. Moreover, controlling the shape and the number of available connections of DNA monomers allows to craft complex geometrical architectures.