Directing the Assembly of Molecules and Materials using DNA as a Programmable Glue

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The idea behind our research is to use DNA as a programmable tool for directing the self-assembly of molecules and materials. The unique specificity of DNA interactions, our ability to code specific DNA sequences and to chemically functionalize DNA, makes it the ideal material for controlling self-assembly of components attached to DNA sequences. We have developed some new approaches in this area such as the use of DNA for self-assembly of organic molecules,[1-2] and for electrochemical sensors.[3]

The DNA origami method was first reported by Rothemund in 2006,[4] and in its relatively short lifetime several reports have demonstrated that it is an excellent tool to program self-assembly of DNA nanostructures. For the design of DNA origami we have recently developed a software package that semi-automates the design process allowing the user to focus on optimization and modification of the design.[5] After initial 2D designs we made a 3D DNA origami box which was characterized by AFM, Cryo-EM, SAXS, and the lid motion was monitored by FRET.[6]

DNA origami also provides a unique platform for the assembly of other materials, since the >200 staple strands used to assemble the M13mp18 genome can, in principle, be extended and each may provide a unique recognition sequence at the surface of origami structures. In this presentation it is demonstrated how DNA origami can be used to assemble organic molecules, study chemical reactions with single molecule resolution,[7] and position dendrimers and other materials.

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