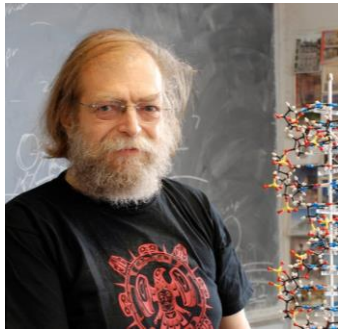
Supramolecular Chemistry with DNA



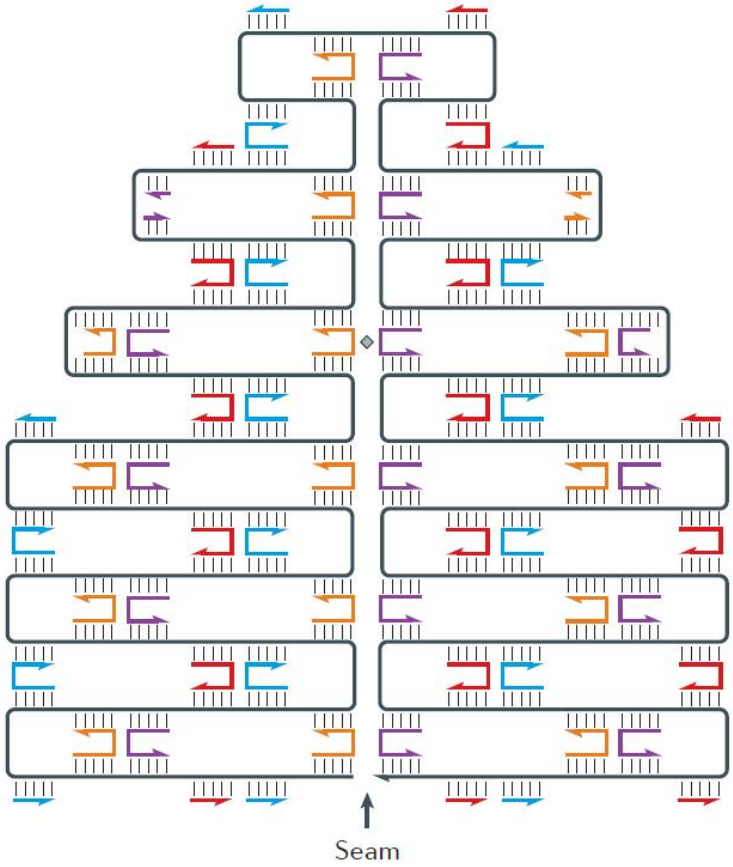
DNA nanotechnology

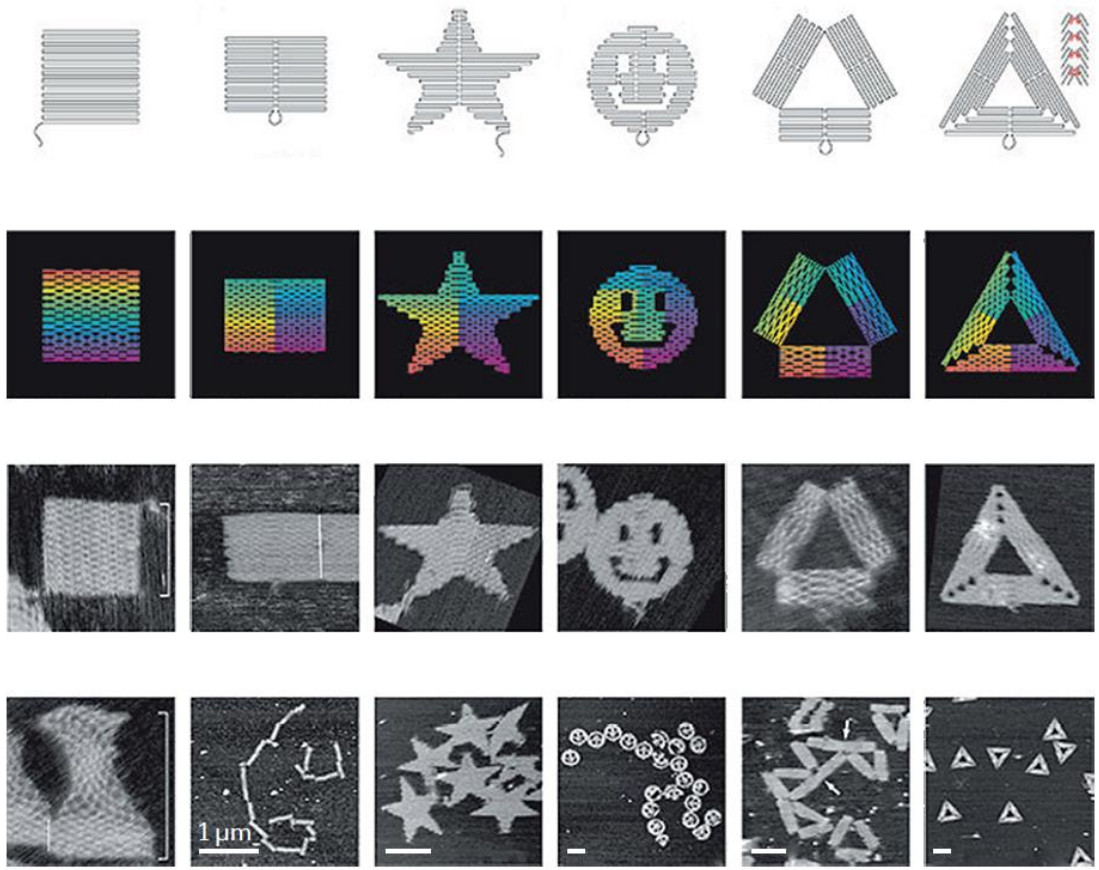
Nadrian C. Seeman[1] and Hanadi F. Sleiman[2]

Abstract | DNA is the molecule that stores and transmits genetic information in biological systems. The field of DNA nanotechnology takes this molecule out of its biological context and uses its information to assemble structural motifs and then to connect them together. This field has had a remarkable impact on nanoscience and nanotechnology, and has been revolutionary in our ability to control molecular self-assembly. In this Review, we summarize the approaches used to assemble DNA nanostructures and examine their emerging applications in areas such as biophysics, diagnostics, nanoparticle and protein assembly, biomolecule structure determination, drug delivery and synthetic biology. The introduction of orthogonal interactions into DNA nanostructures is discussed, and finally, a perspective on the future directions of this field is presented.

Nature Reviews Chemistry **2018**, *3*, 17068.

2D Structures (DNA Origami)





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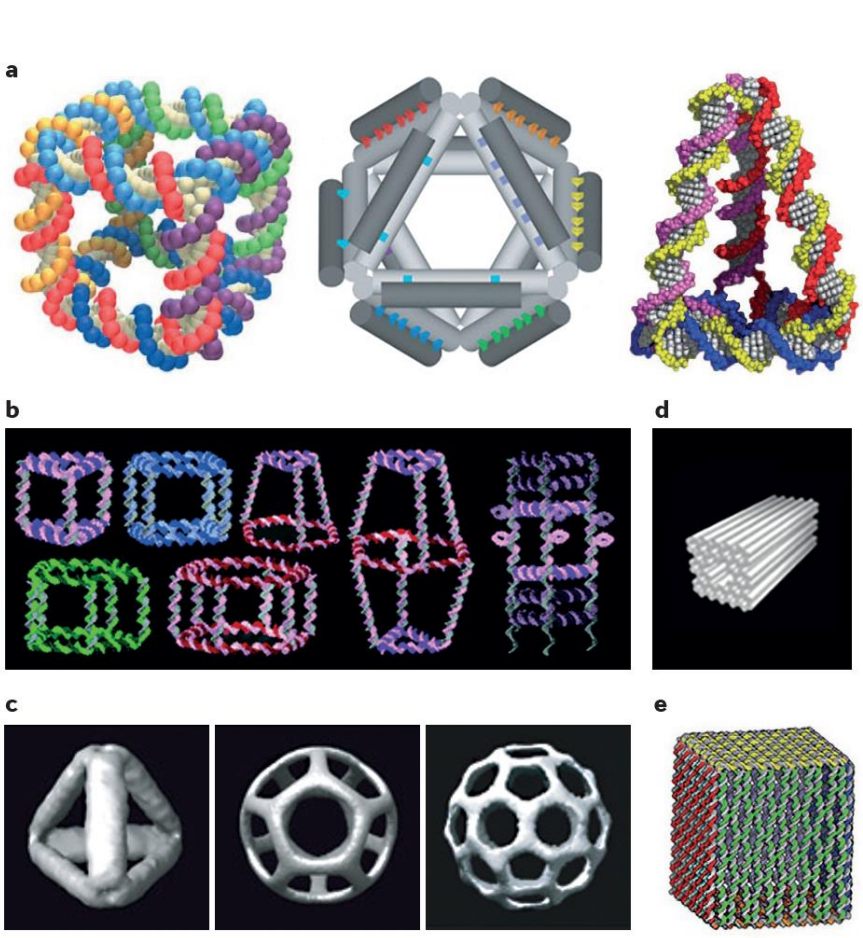
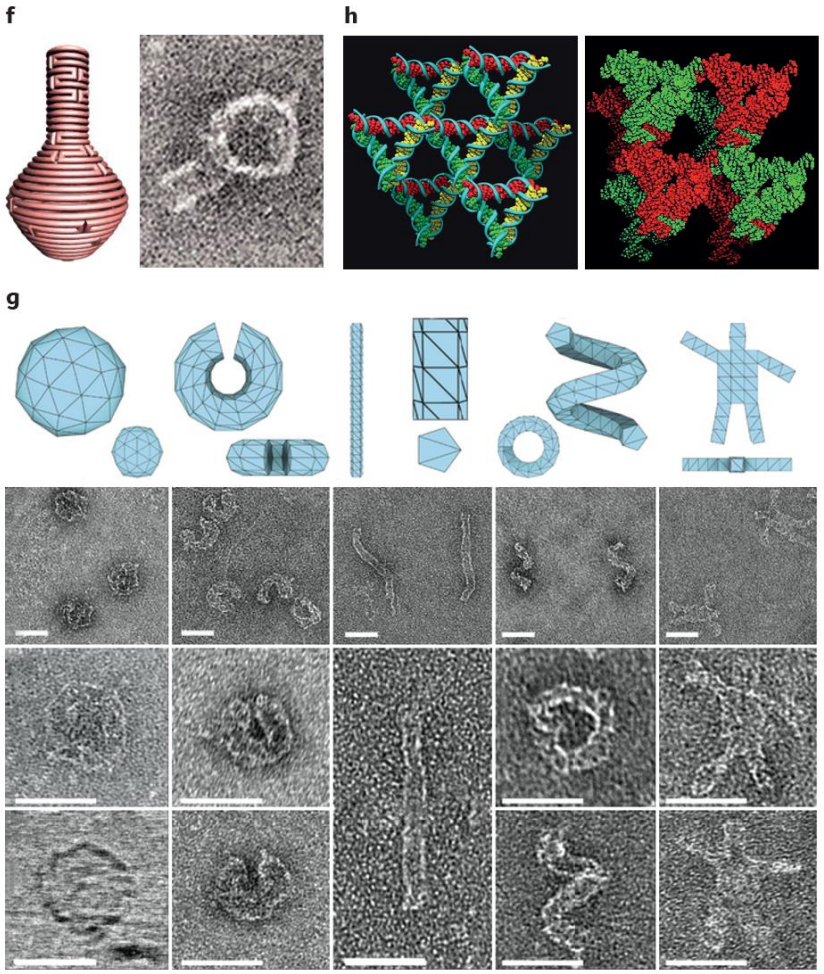
3D Structures





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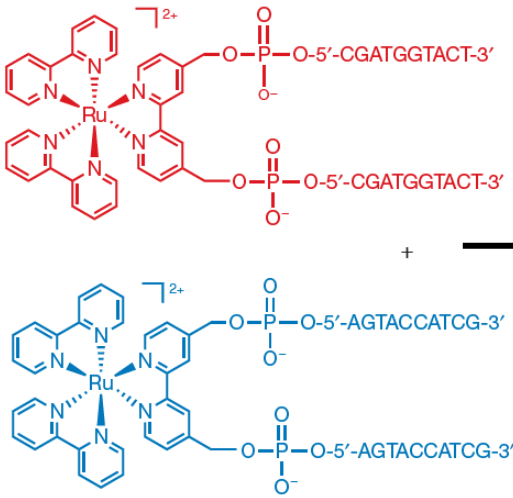
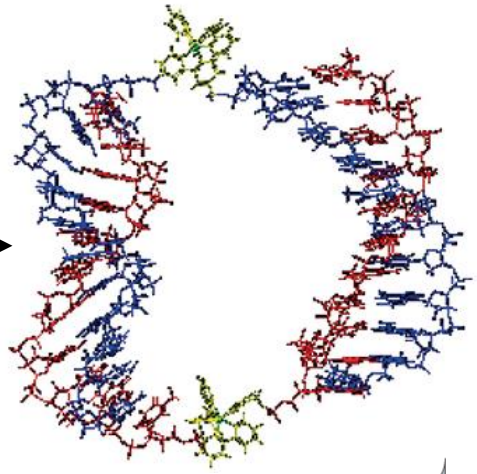
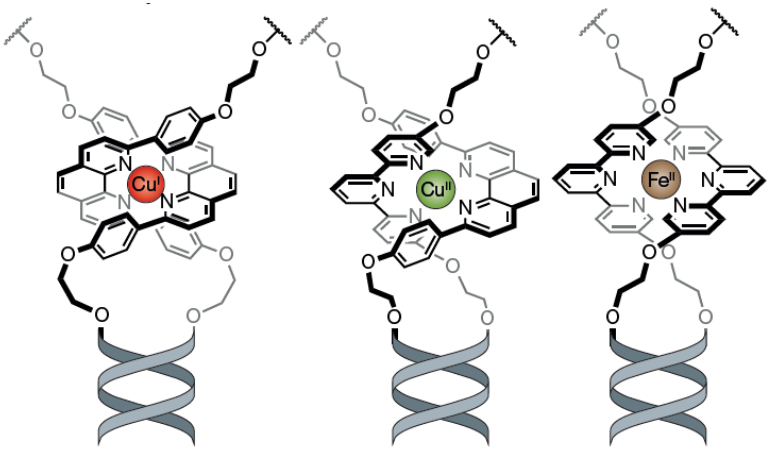
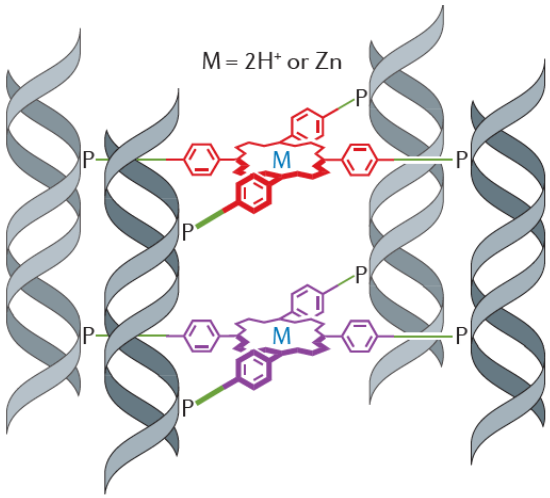
Hybrid Structures









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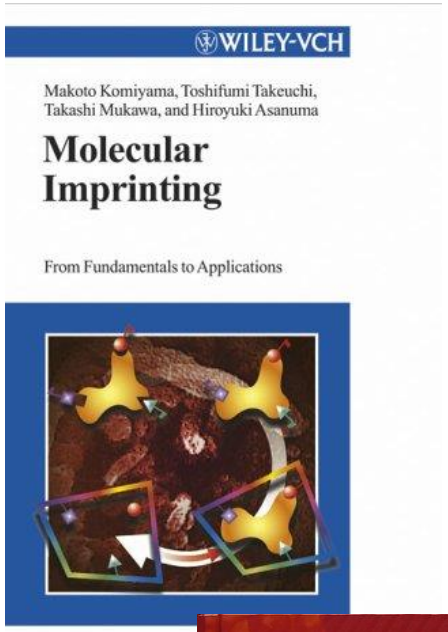
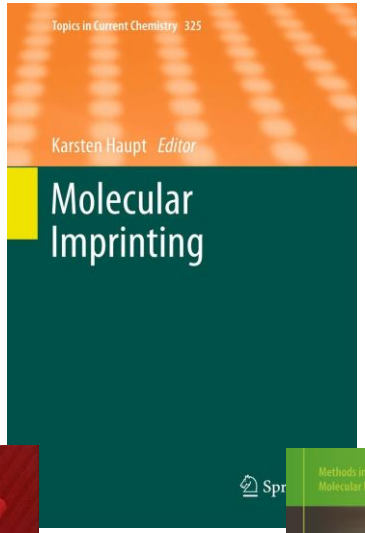
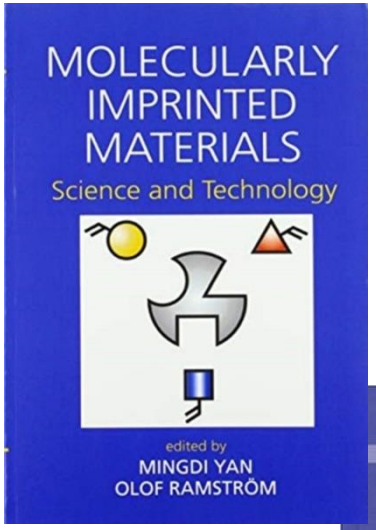
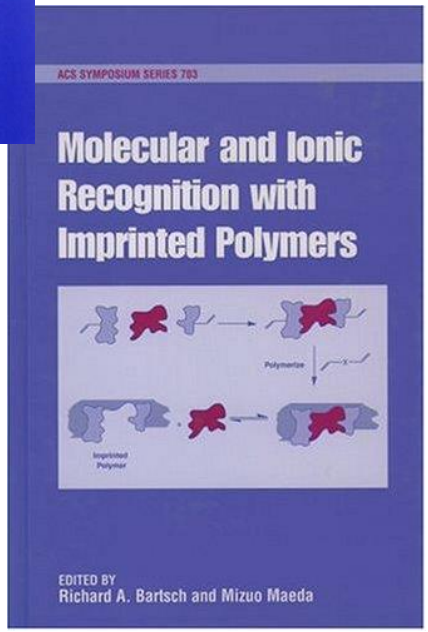
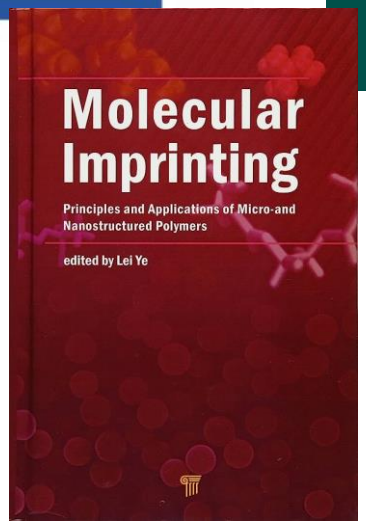
Molecular Imprinting

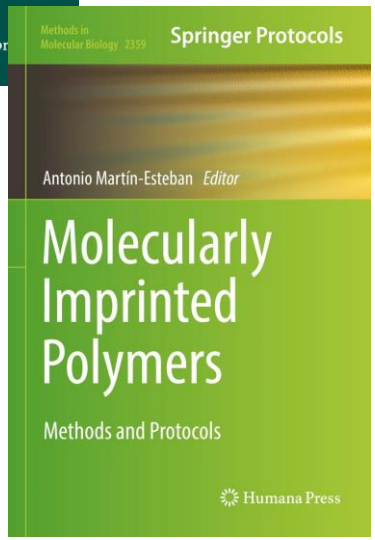




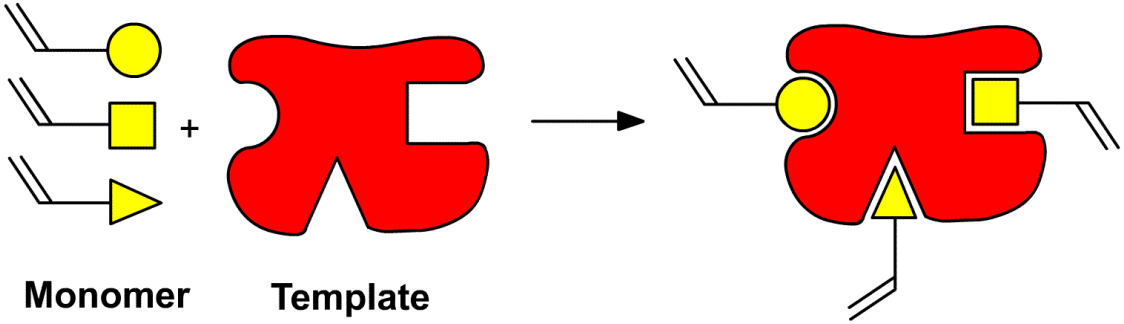


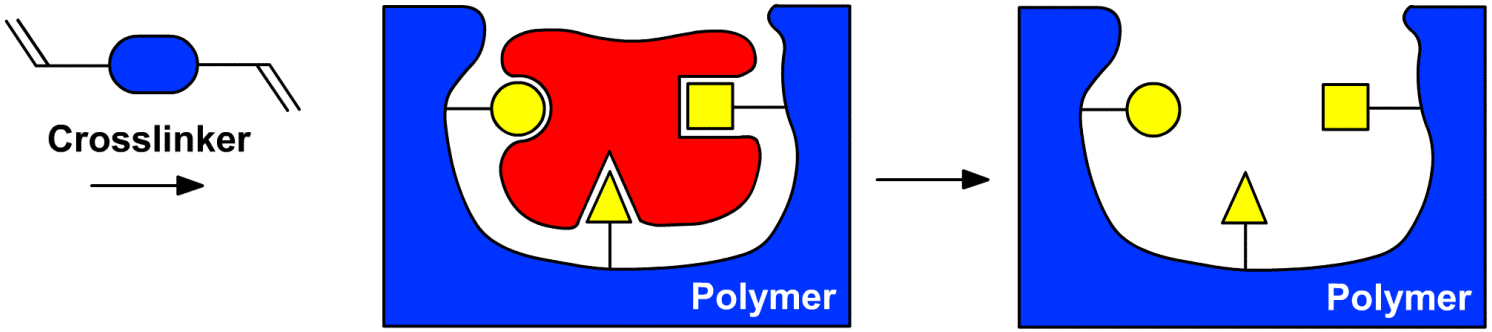






Molecular Imprinting – The Basic Concept

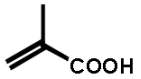




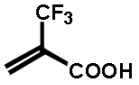
Molecularly Imprinted Polymer
“MIP”

Functional Monomers and Crosslinkers

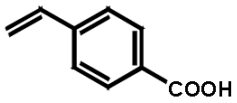
acrylic acid



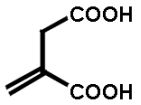
methacrylic acid



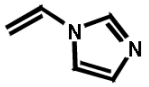
trifluoro-methacrylic acid



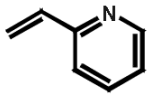
4-vinylbenzoic acid



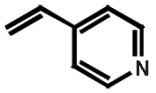
itaconic acid



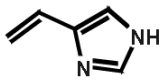
1-vinylimidazole



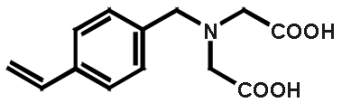
2-vinylpyridine



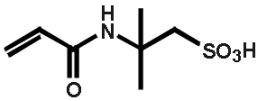
4-vinylpyridine



4(5)-vinylimidazole

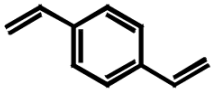


4-vinylbenzyl-iminodiacetic acid

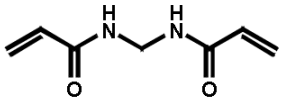


2-acrylamido-2-methyl-
1-propane sulphonic acid

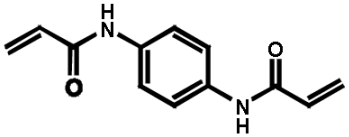
Functional monomers



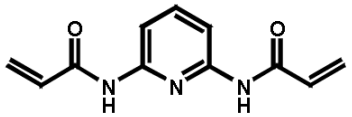
4-divinylbenzene



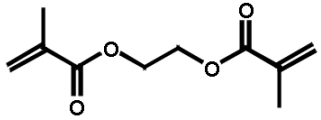
N,N'-methylene-bisacrylamide



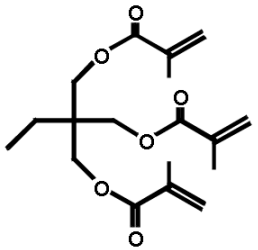
N,N'-phenylene-bisacrylamide



2,6-bisacrylamidopyridine



ethylene glycol dimethacrylate



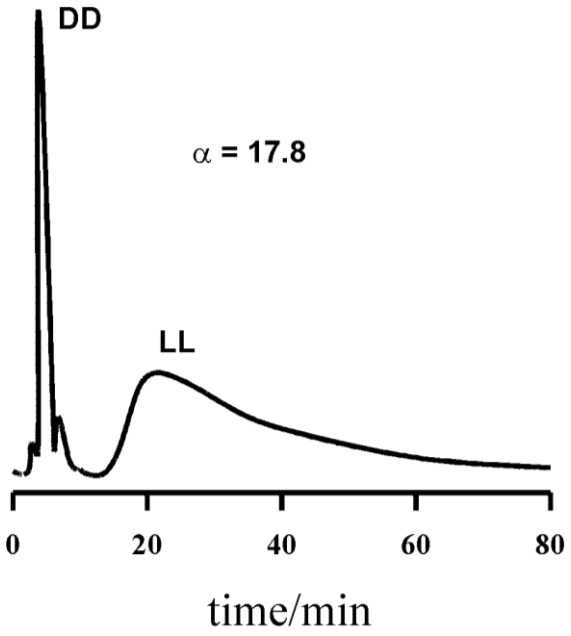
trimethylolpropane
trimethacrylate

Crosslinkers

MIPs – Advantages and Disadvantages

Advantages	Disadvantages
• Cheap	• Inhomogeneous binding sites
• Easy to prepare	• Work poorly in water
• Robust	• Recognition of macromolecules difficult
• Available in many forms (bulk, beads, films)	

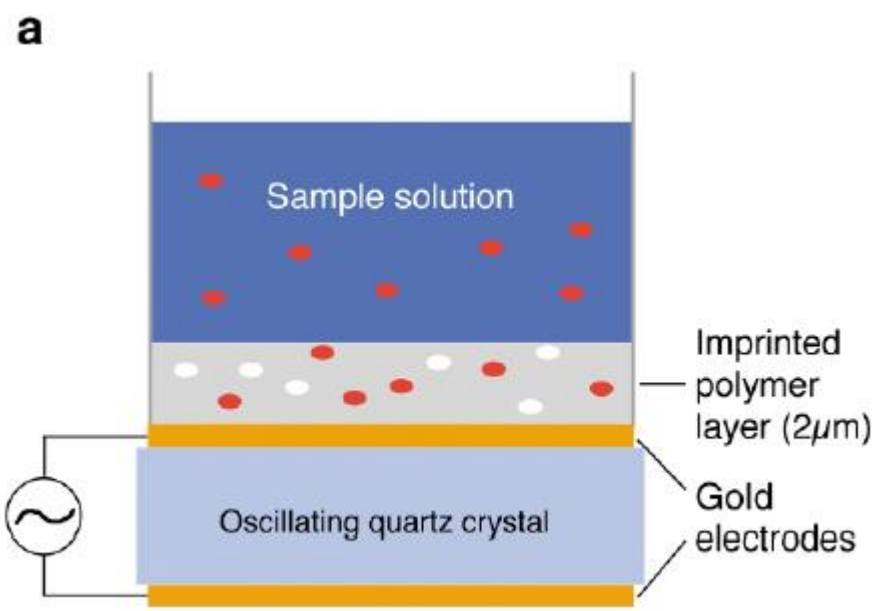
Applications – Chromatography

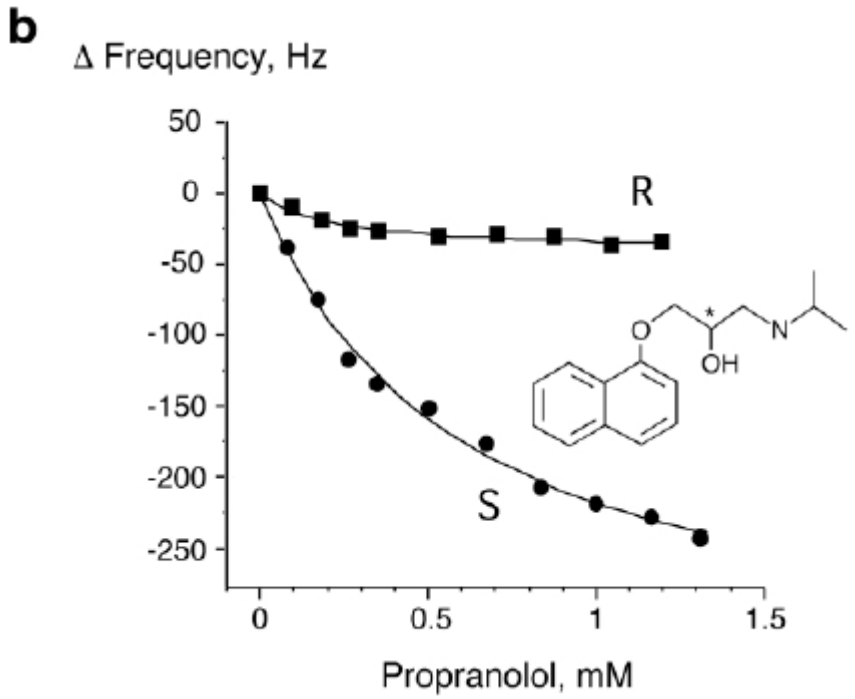


Chiral separation of N-acetyl-L-Phe-L-Trp-OMe from its enantiomer by a polymer imprinted against the LL-isomer. The separation factor amounted to 17.8.

Imprinting is highly suitable for separation, allowing the preparation of tailor-made supports with pre-determined selectivity. Of special interest is in this line is chiral separations. Using imprinting protocols, highly efficient chirally discriminating phases may be produced.

Applications – Sensors



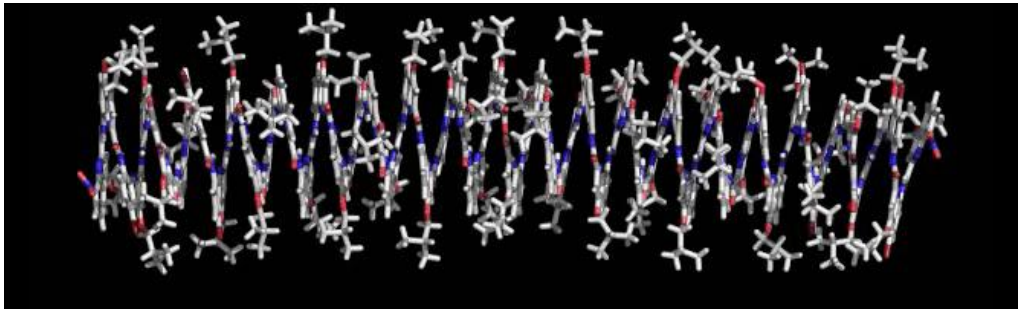


a) Schematic representation of a piezoelectric microgravimetry sensing device containing an imprinted polymer film as the recognition element.

b) Dependence of the resonance frequency change of the QCM resonator on the concentration of *R*-propranolol and *S*-propranolol.

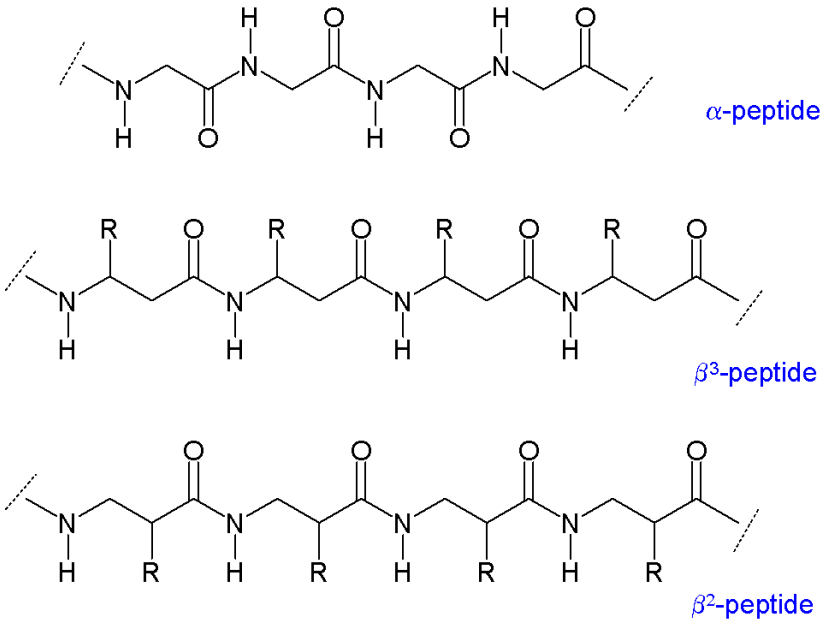
Synthetic Foldamers

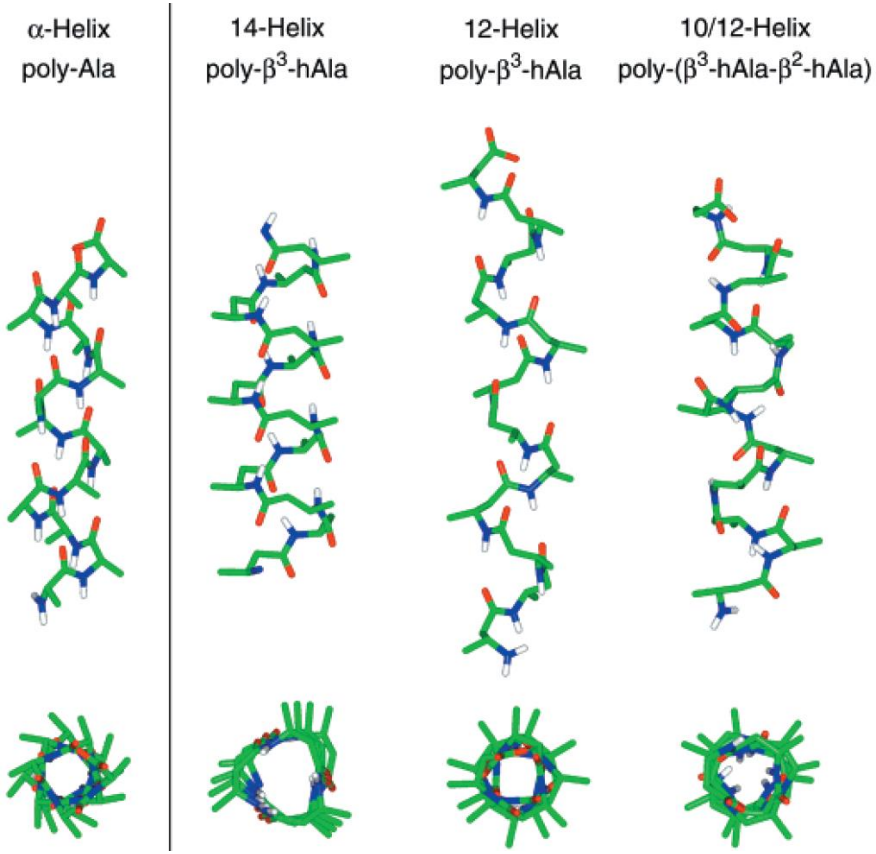
Foldamers: Oligomers that adopt predictable and well-defined conformations



(X-ray of a synthetic foldamer from the Huc group)

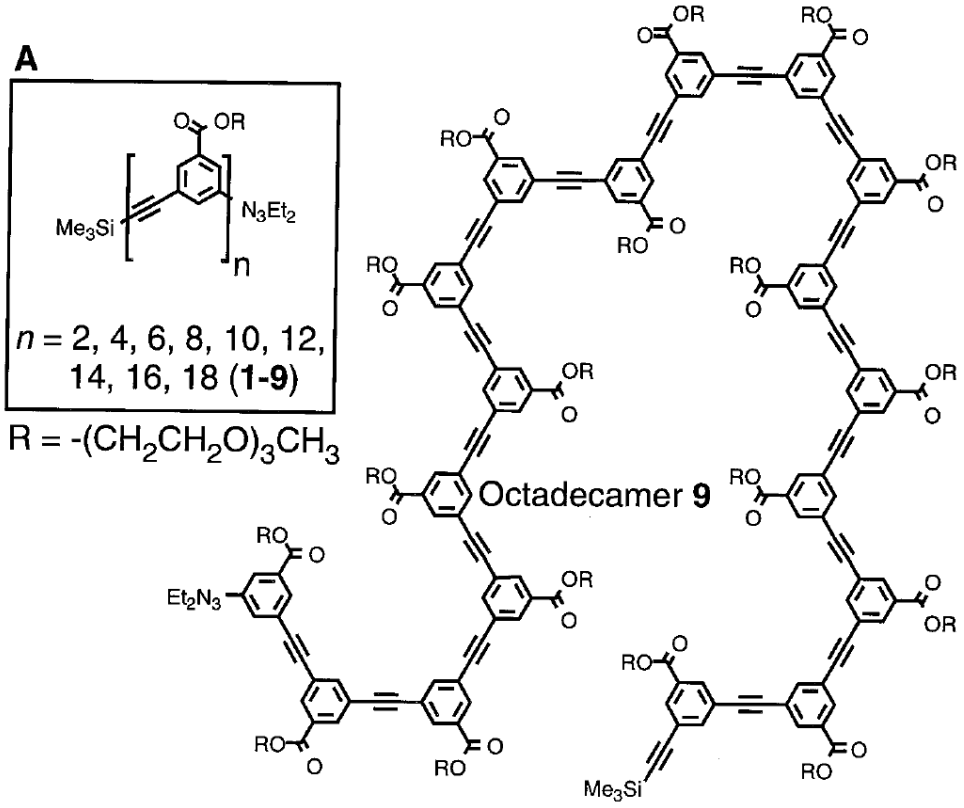
β-Peptides

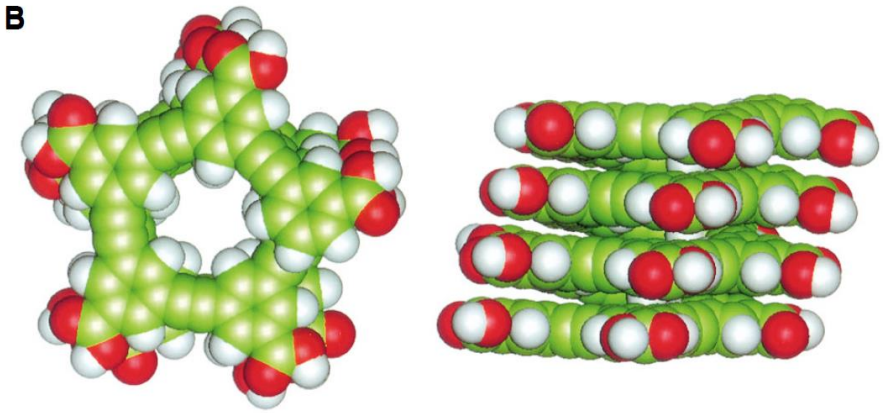




R. P. Cheng, S. H. Gellman, W. F. DeGrado, *Chem. Rev.* **2001**, *101*, 3219.

Phenylacetylene Oligomers

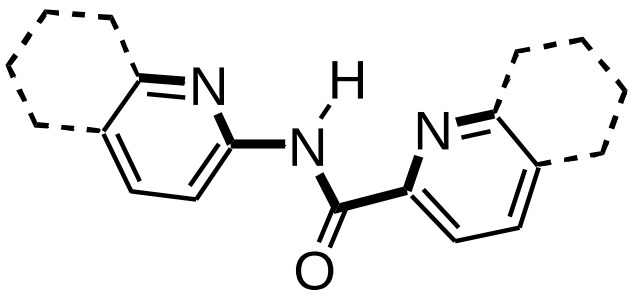




Solvophobic interactions drive the folding transition, which is sensitive to chain length, solvent, and temperature.

J. S. Moore *et al.*, *Science* **1997**, *277*, 1793.

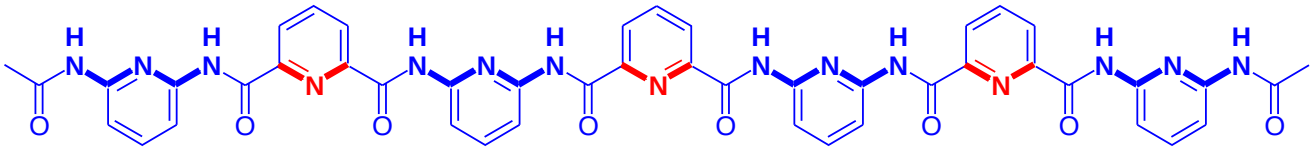
Building Blocks



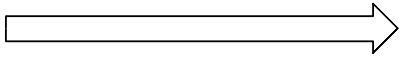
DESIRED FEATURES

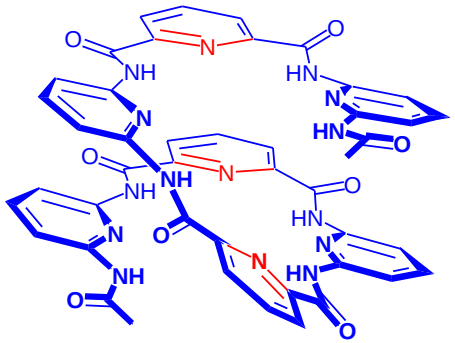
- Ease of Synthesis
- Predictability of the conformation
- Stability of the structures
- Tunability

A Successful Design



folding





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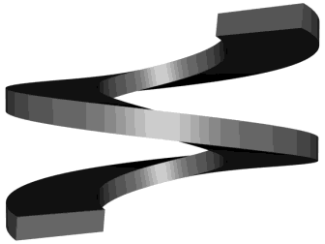

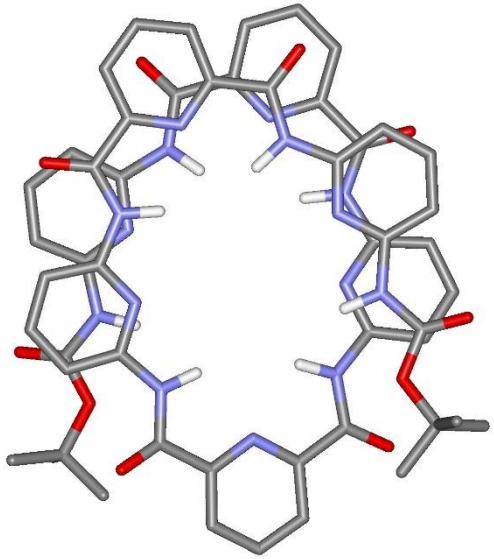

I. Huc et al. *Chem. Eur. J.* **2001**, *7*, 2798.