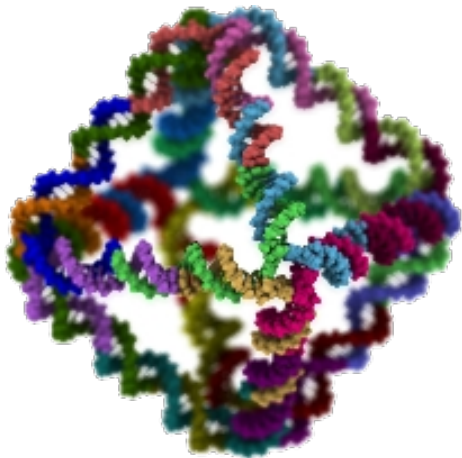


Programmable Self-Assembly of Bio-Abiotic Hybrid Materials

NSF Nanobiology



Yonggang Ke

Biomedical Engineering, Emory University
and Georgia Institute of Technology

DNA nanostructures and nanomachines

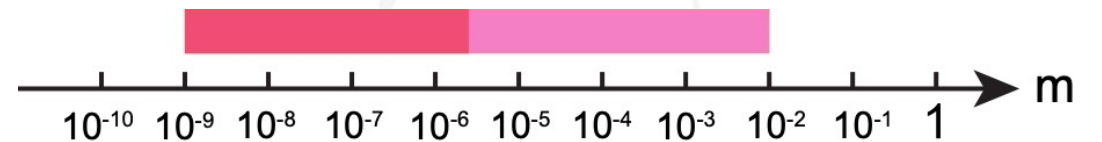
Coding interactions



DNA hybridization



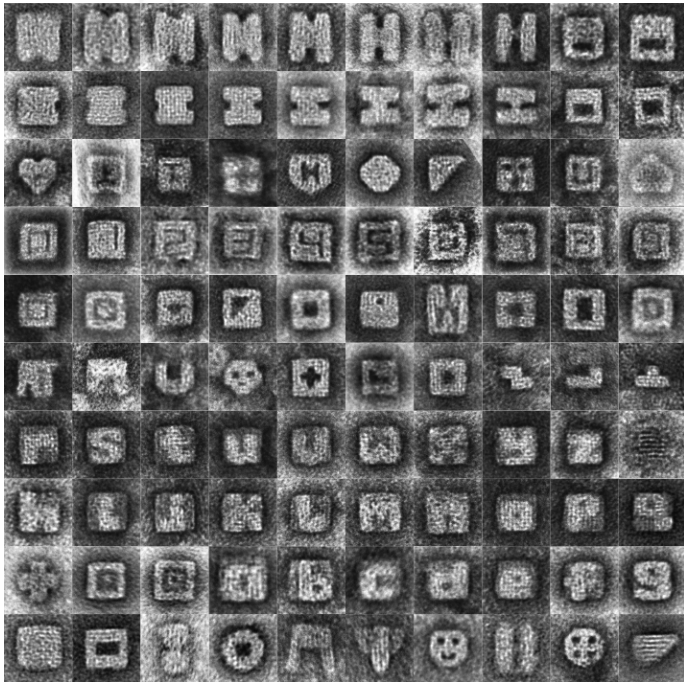
Nanostructure



What make the approach work well?

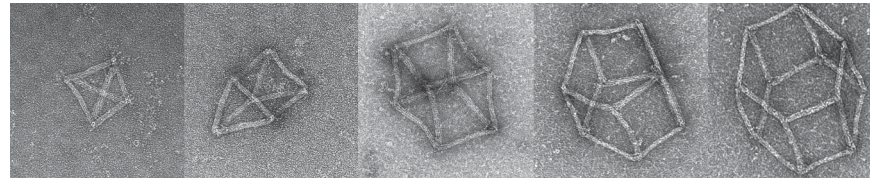
Complex interactions (both intra-molecular and inter-molecular) are programmable, because of the simple and robust molecular coding language of DNA (basepairing).

Examples of complex DNA nanostructures



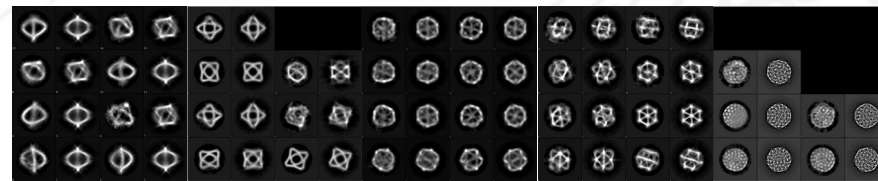
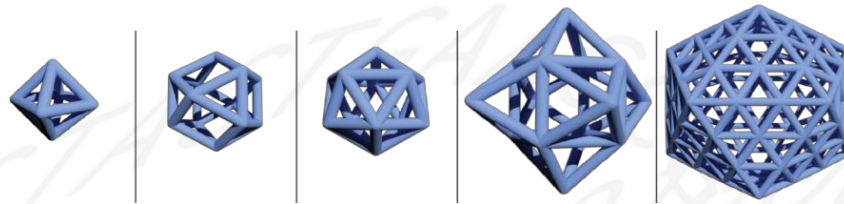
Science 2012

50nm

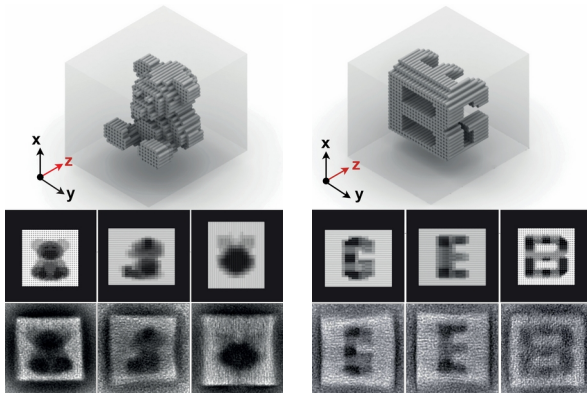


Science 2014

100nm

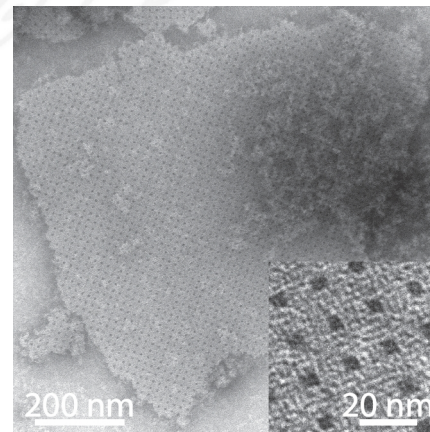


Nature Comm 2019

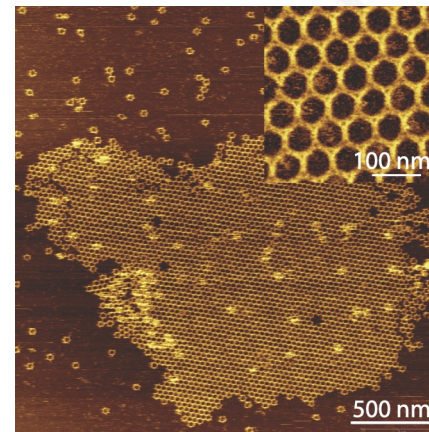


Nature 2017

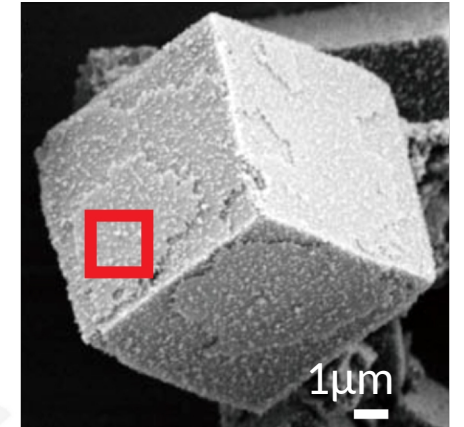
100nm



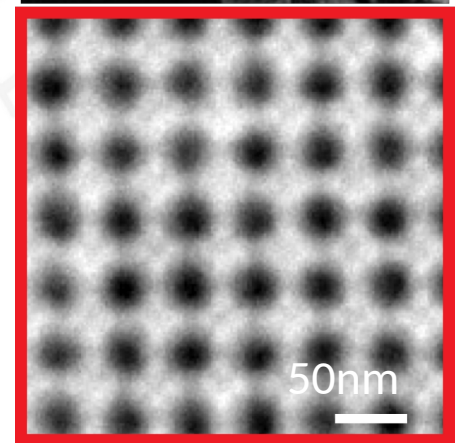
Nature Chem 2014



JACS 2014



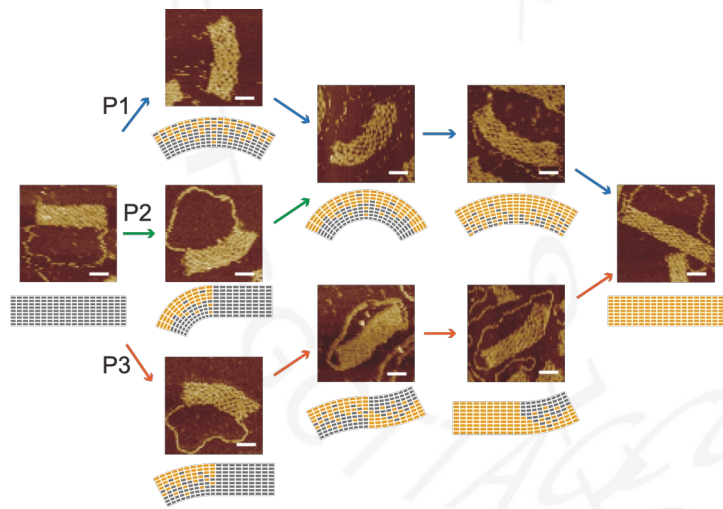
1μm



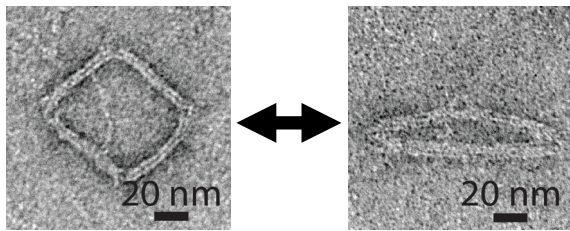
50nm

Nature Comm 2021

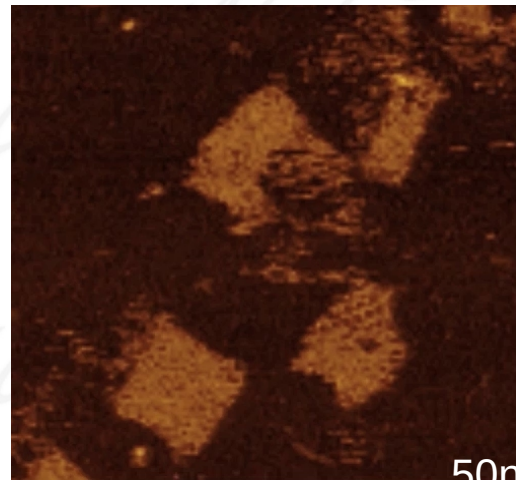
Examples of DNA nanomachines



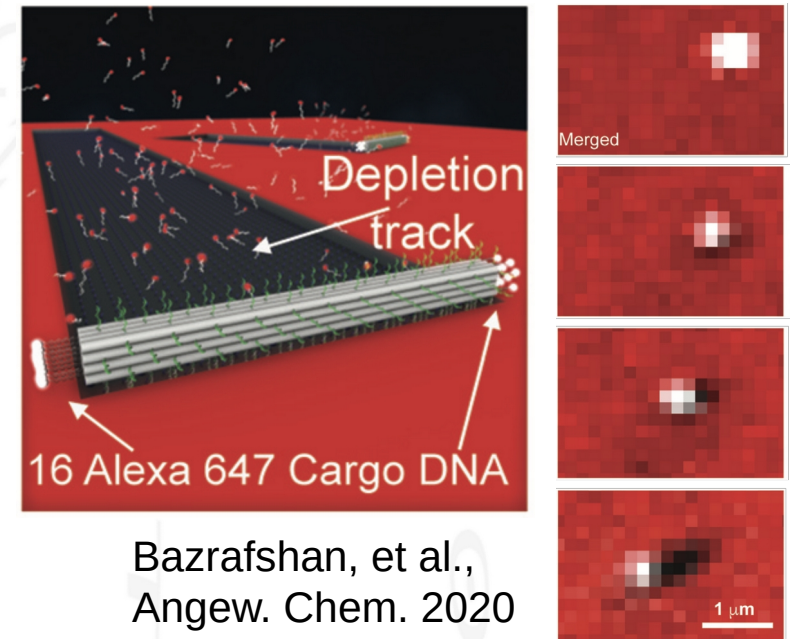
Wang, et al., JACS 2021



Ke, et al., Nat.Comm. 2016

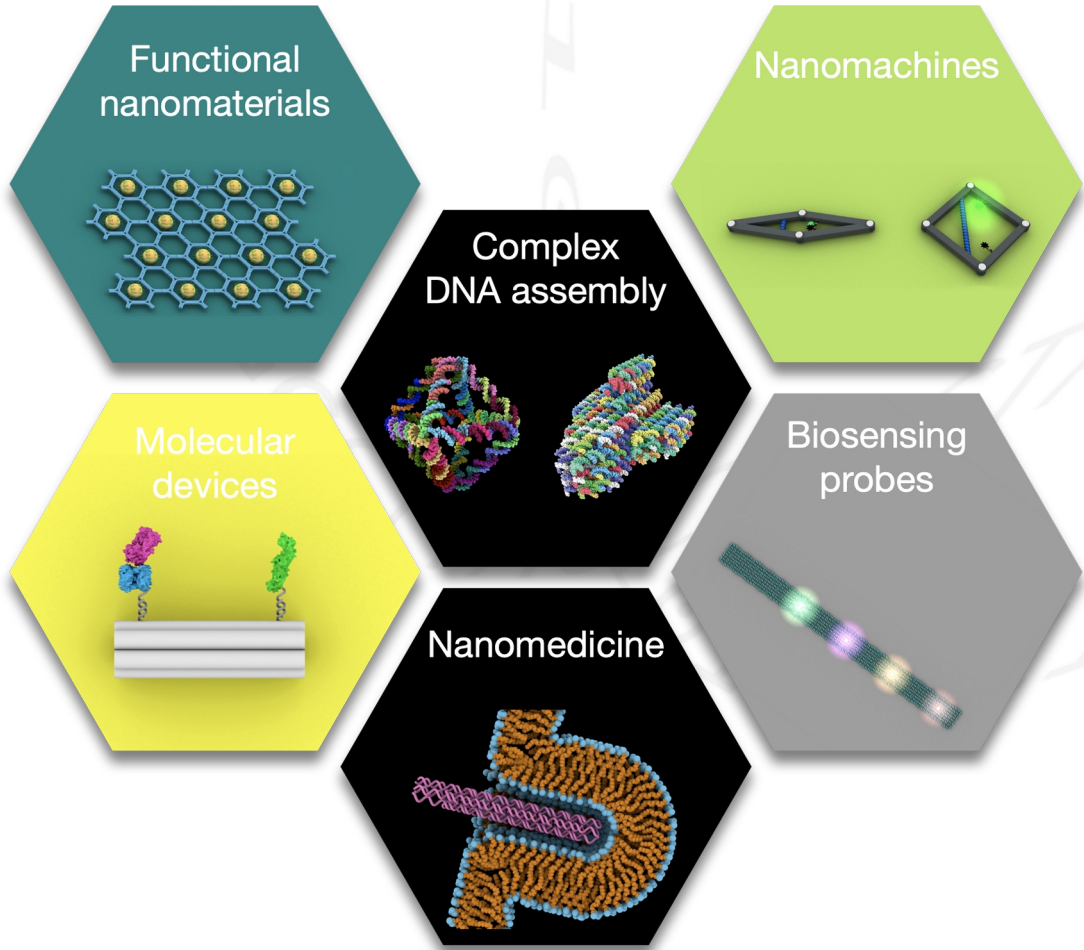


Song, et al., Science 2017

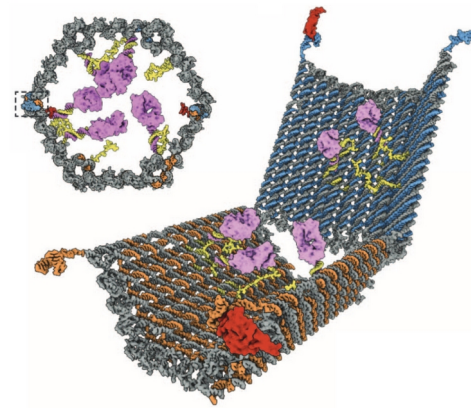


Bazrafshan, et al.,
Angew. Chem. 2020

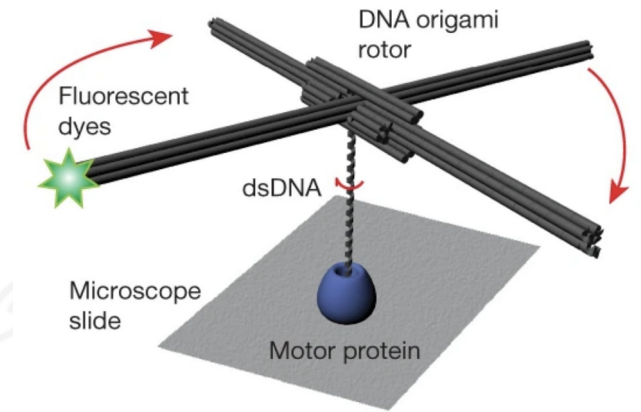
DNA nanostructure enabled applications



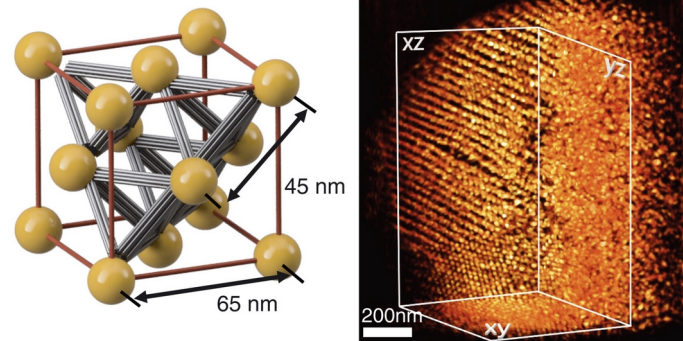
Combining “**designer DNA nanostructures**” with “**assembly of other molecules/materials**” provides more enabling platforms



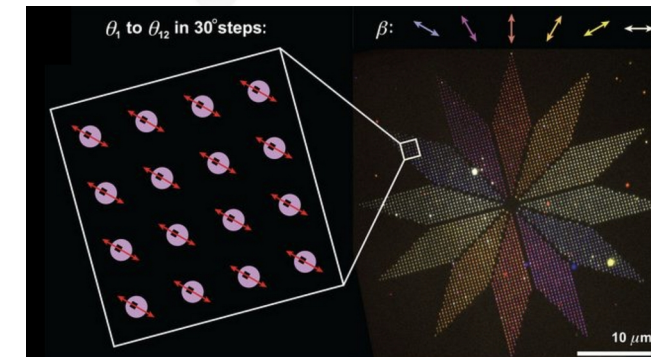
Douglas, et al., Science 2012



Kosuri, et al., Nature 2019

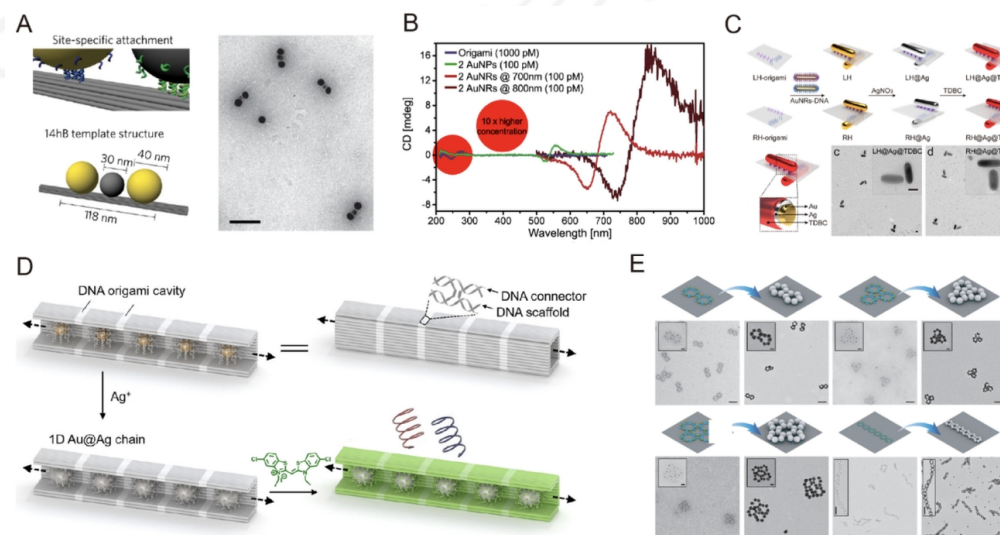
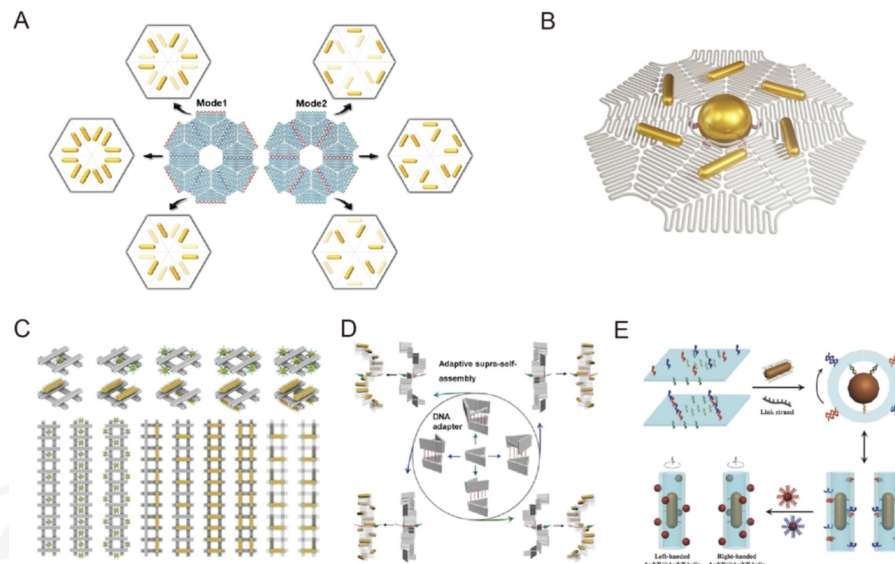


Michelson, et al., Science 2022

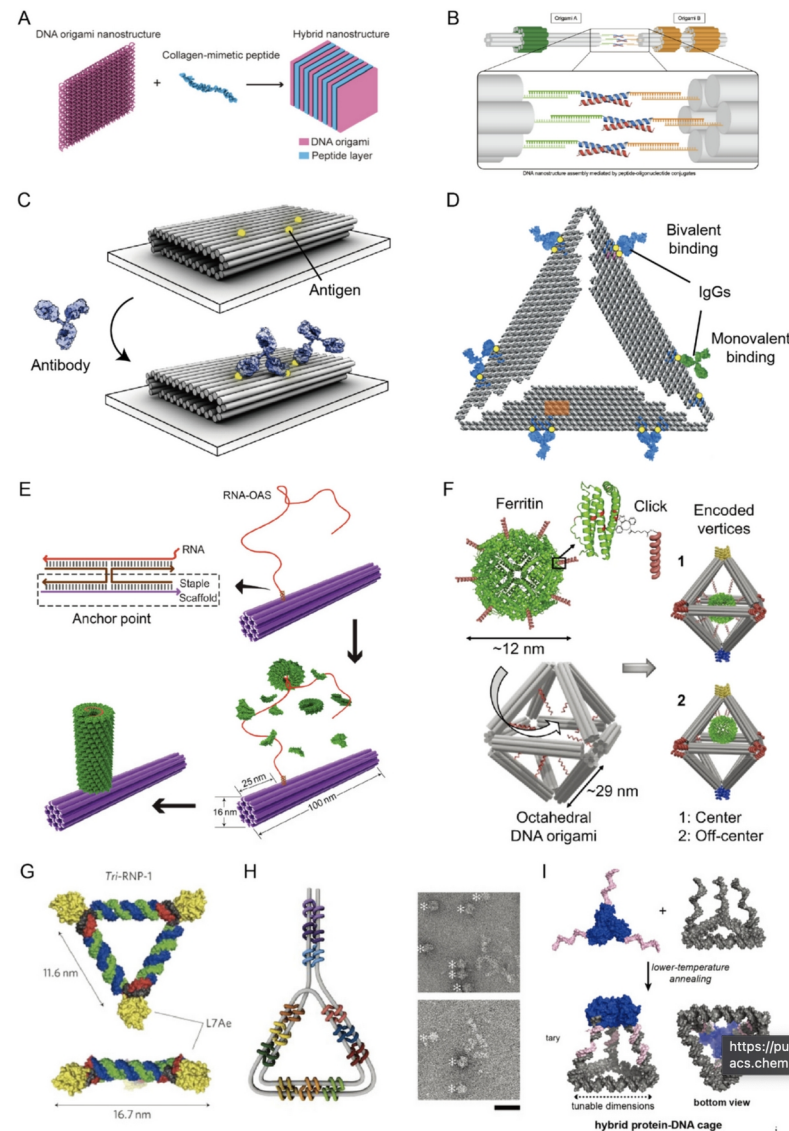


Gopinath, et al., Science 2021

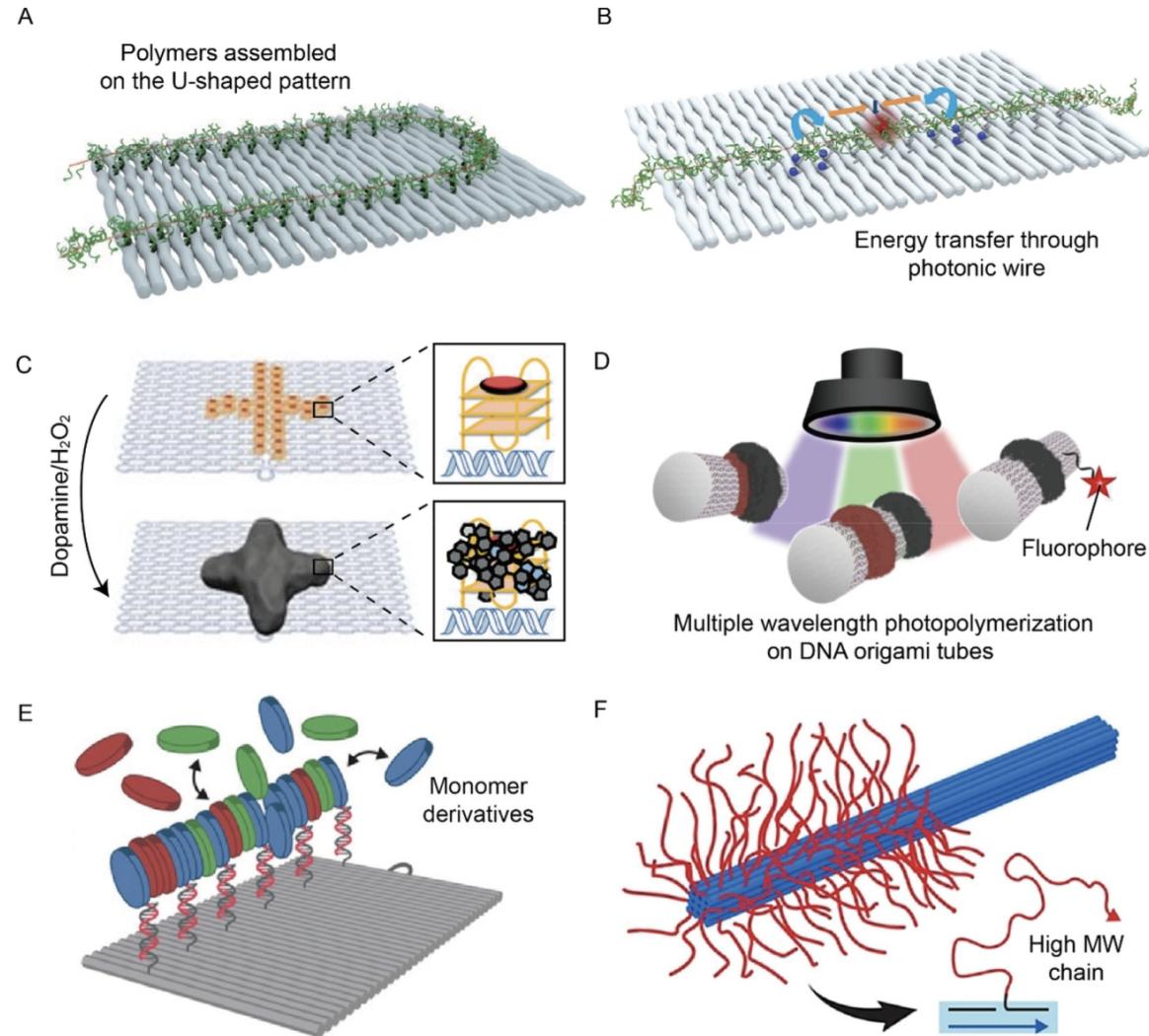
Programmable assembly of nanoparticles and nanorods



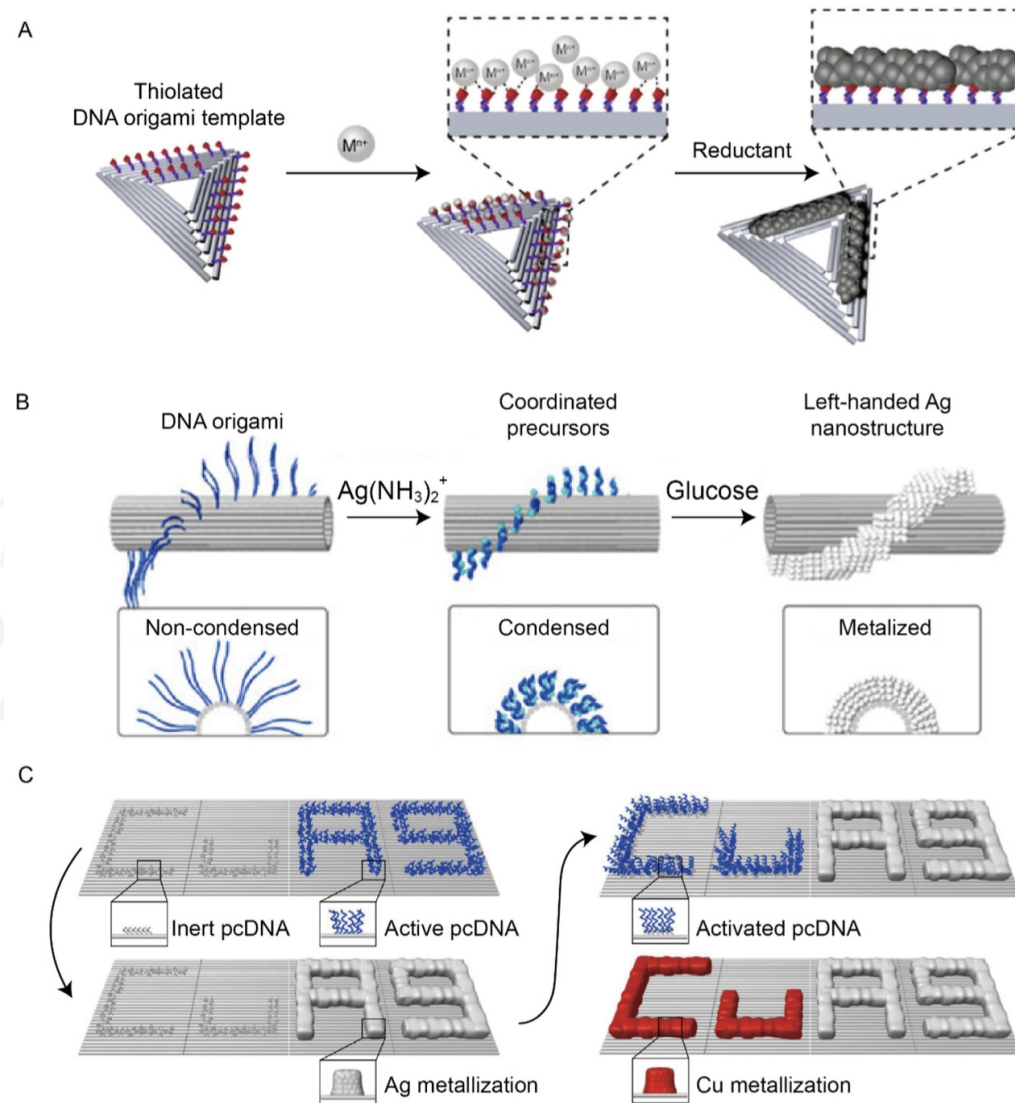
Position-controlled spatial organization of proteins



Controlled polymer assembly or growth

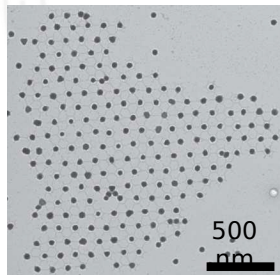


Selective mineralization/metallization

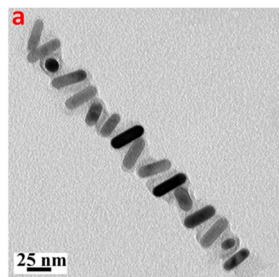


DNA-directed assembly and fabrication of nanomaterials/biomaterials

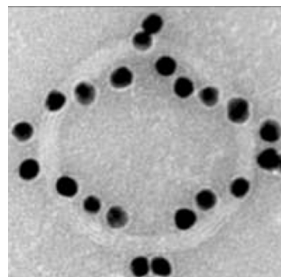
Scaffolding



Wang, et al., JACS 2016

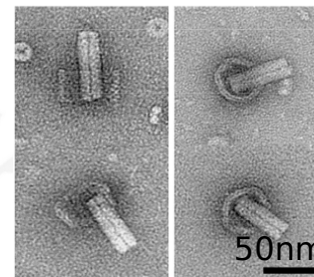


Lan, et al., JACS 2015

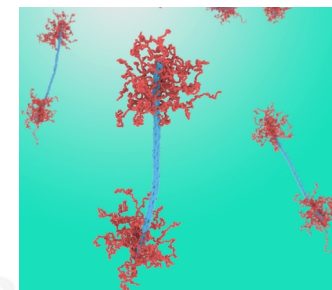


Urban, et al., JACS 2016

In-situ assembly/growth

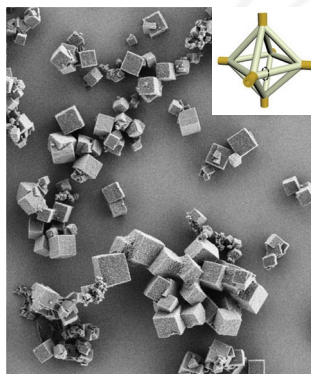


Zhou, et al., JACS 2020

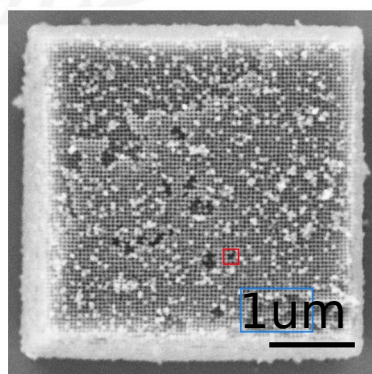


Yang, et al.,
Angewandte Chemie
2021

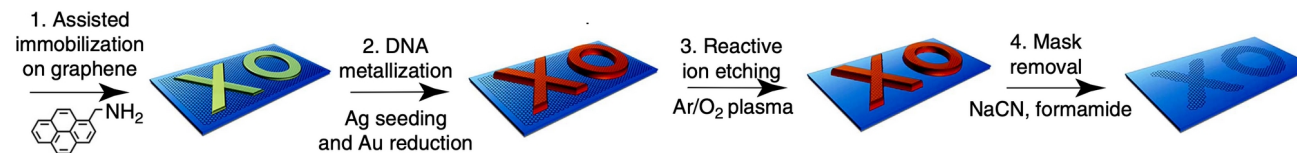
Mineralization



Wang, et al., Nature Communications 2021

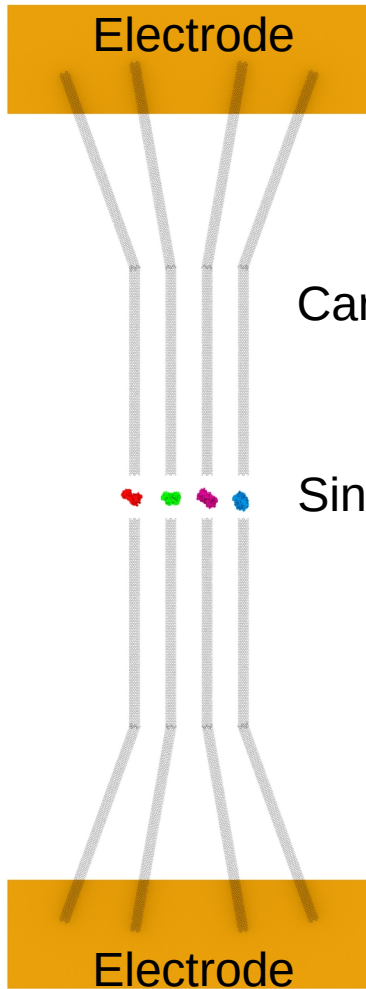


Lithography

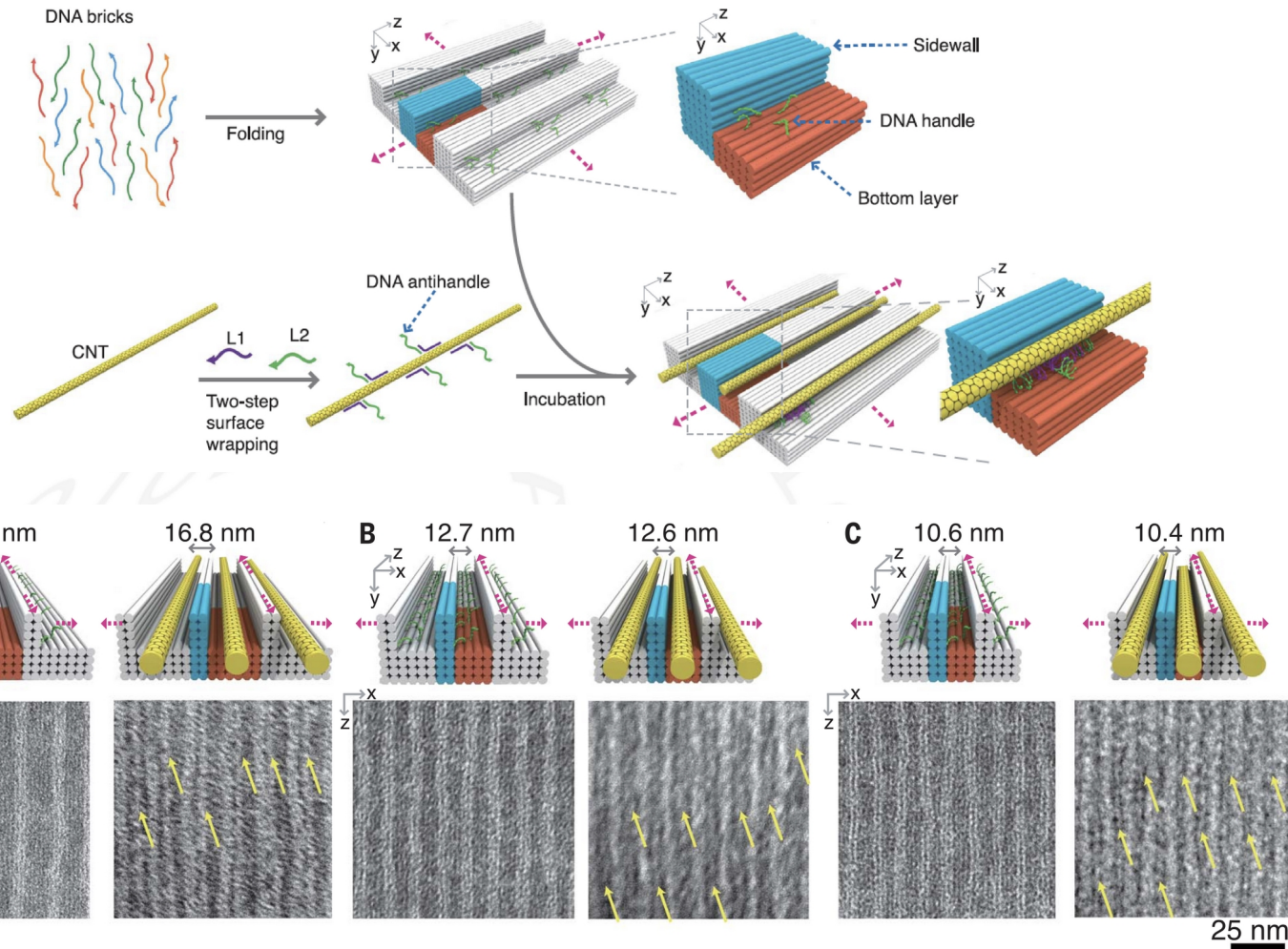


Jin, et al., Nature Communications 2013

Some challenges to improving this technology

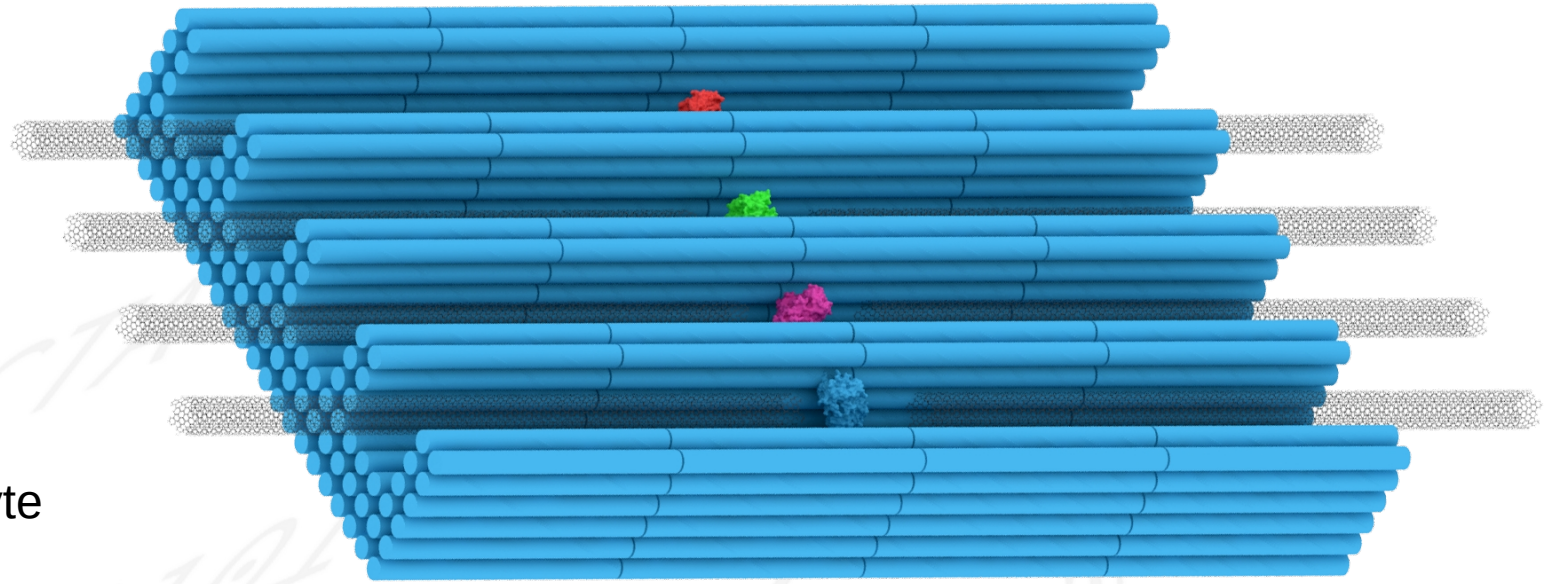
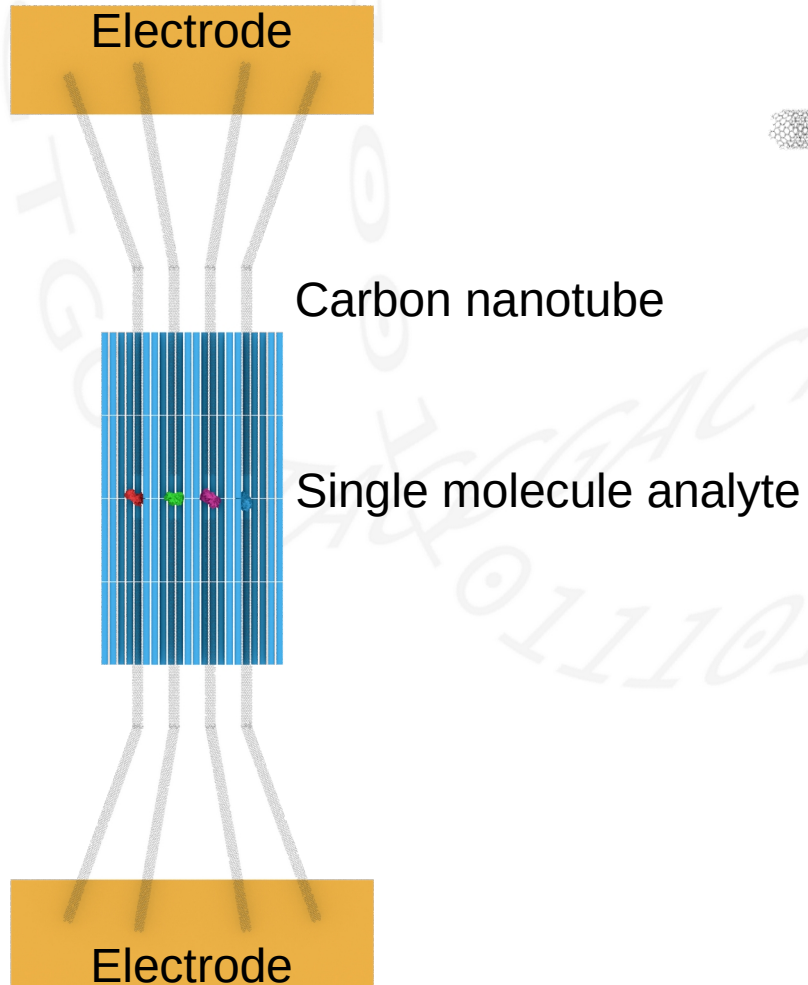


High-density sensor nanoarray



Sun, et al., Science 2020

Some challenges to improving this technology



- (1) High precision, low defect, cost-effective assembly.
- (2) Multicomponent assembly.
- (3) Integration of DNA-based nanodevices into top-down manufactured devices.
- (4) Removal, stabilization, and modifications of DNA-based nanodevices.

High-density sensor nanoarray

Acknowledgements

Lab Members

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