Integrating Biology and Microsystems

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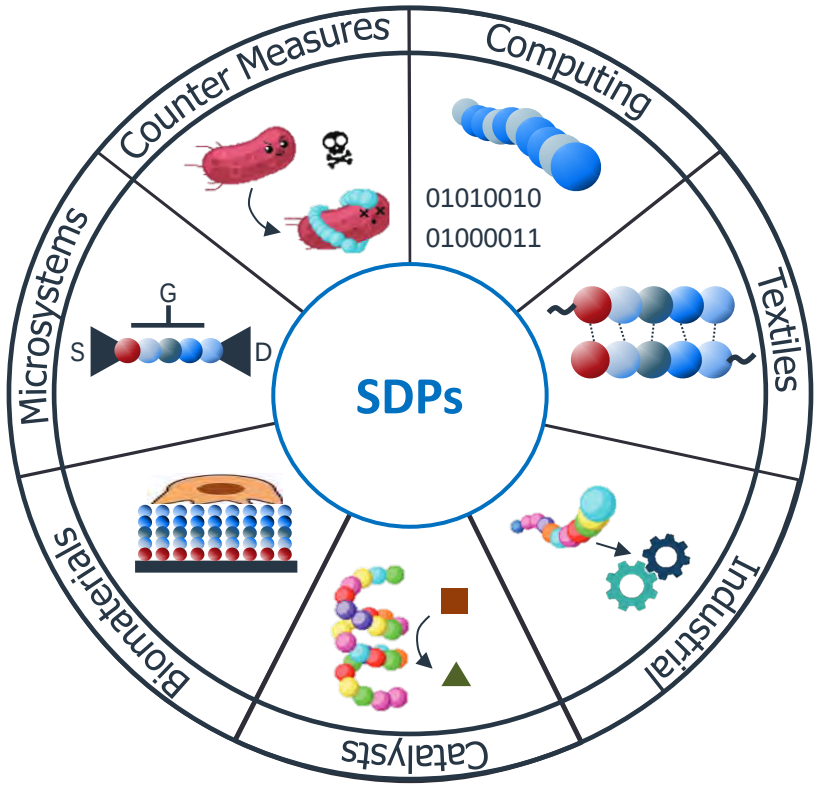
July 24, 2025

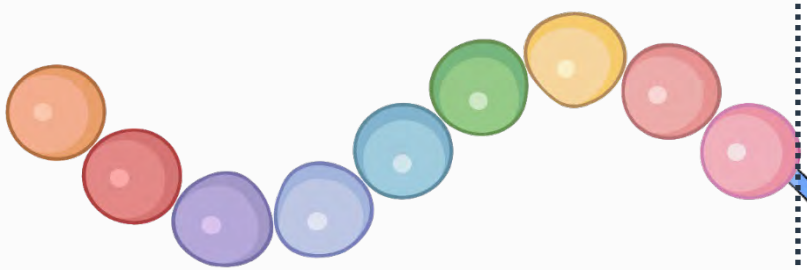
Sequence Defined Polymers (SDPs) Open a Wide Application Space

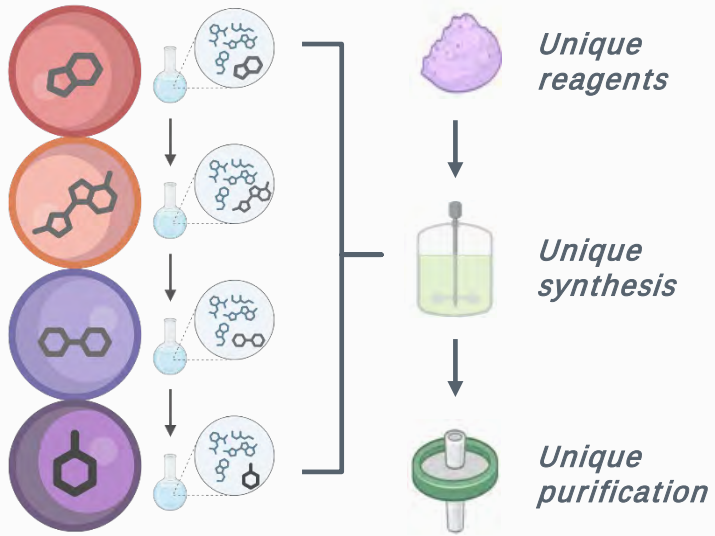
Applications



Novel, high-impact products that can't be manufactured any other way

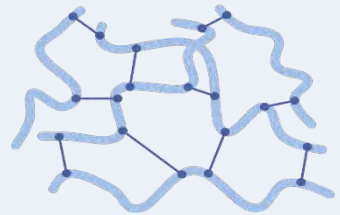
Sequence Limitations





Source: Biorender

Structure Limitations



Structural information

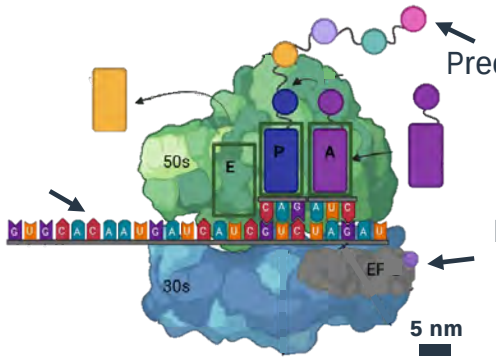
Self-assembly

Source: Biorender

Macromolecular Machines That Synthesize Sequence-Defined Polymers

Nature's Machines

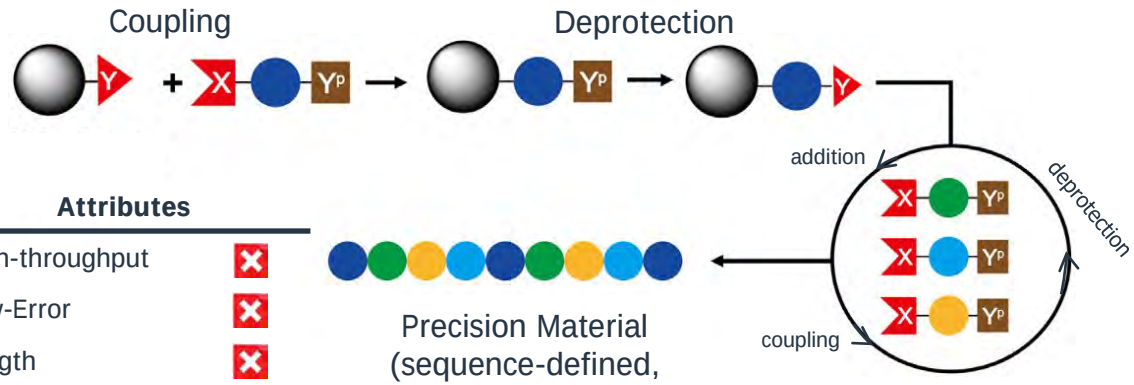
Ishida, A., et al., 10.1021/acs.chemrev.3c00912 (2024)



Attributes	
High-throughput	✓
Low-Error	✓
Length	✓
Chemical variety	✗

Synthetic Chemistry

Shi, Q., et al., 10.1016/j.progpolymsci.2023.101677 (2023)



Attributes	
High-throughput	✗
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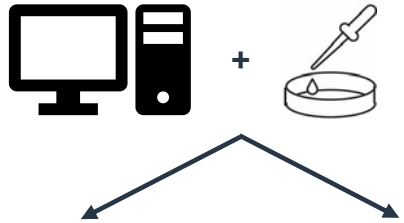
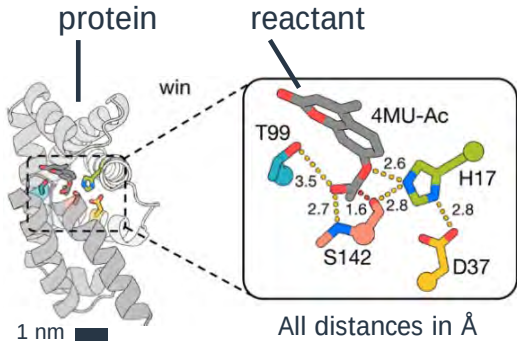
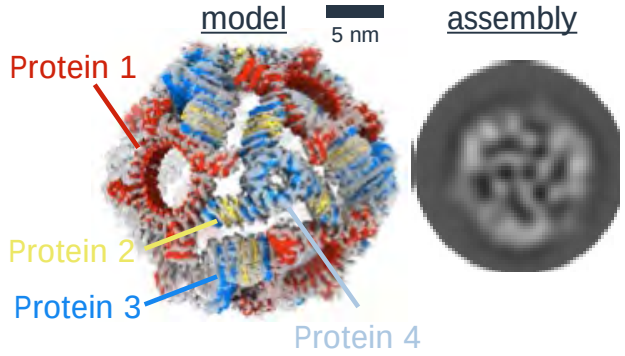
Length	✗
Chemical variety	✓

Molecular Engineering







Template directed precision synthesis

Lauko, A., et al., 10.1126/science.adu2454 (2025)

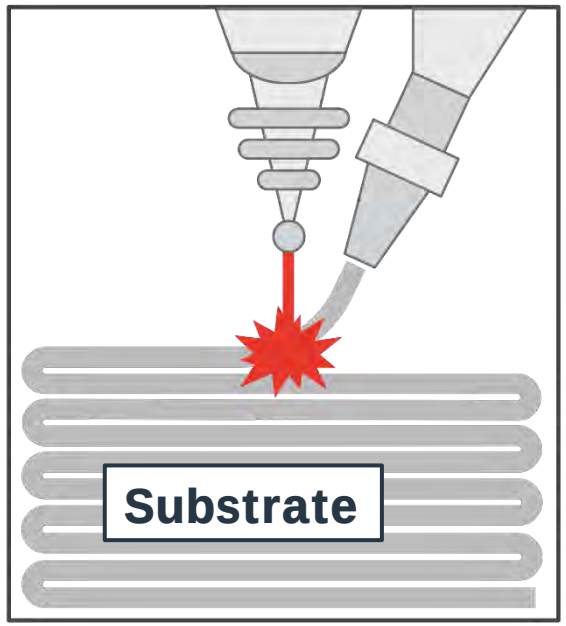
Molecular self-assembly

Huddy, T.F., et al., 10.1038/s41586-024-07188-4 (2024)

Sequence defined materials with wide chemical variety

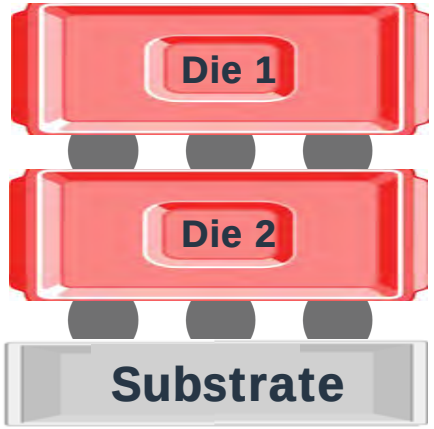
Planarity Limits the Device Architectures We Can Imagine

Channel fabrication

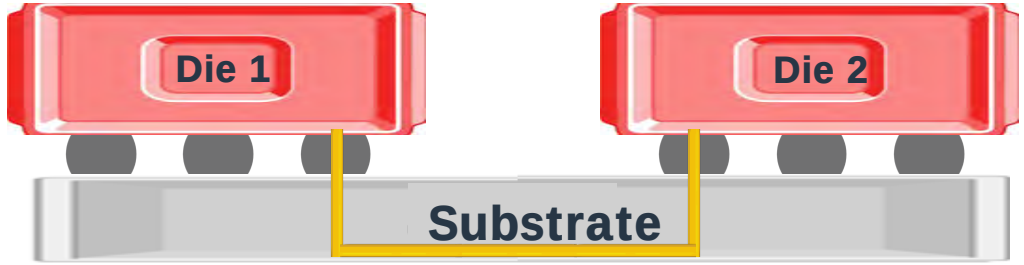


Source: Biorender

Chip Integration



Source: Biorender



Source: Biorender

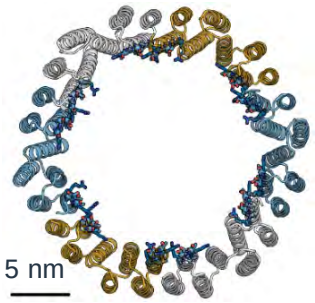
Limitations

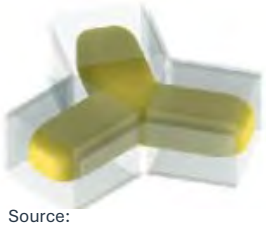
- Heat
- Assembly complexity
- Packing Density
- Bandwidth

Biopolymer Structures Coordinate Functional Materials in 3D

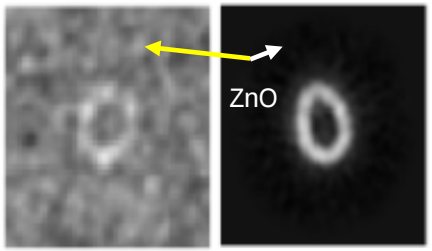
Nanometer scale templated growth

Source: https://www.biorxiv.org/content/10.1101/2024.06.24.600095v1



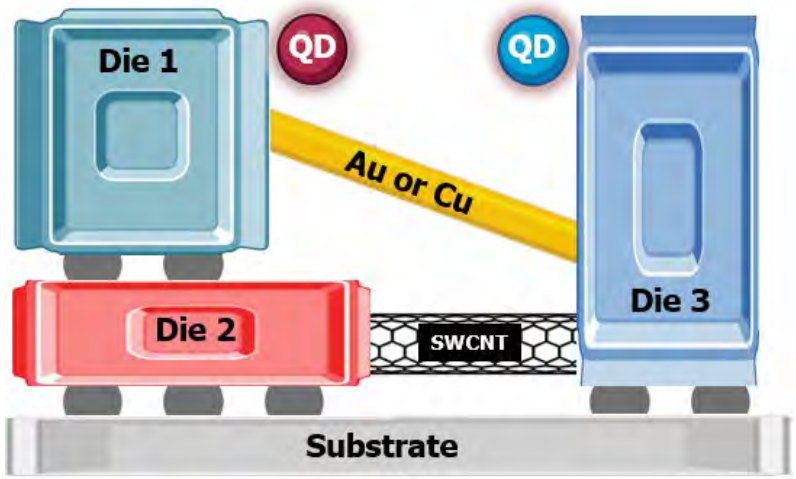


Source: https://www.science.org/doi/10.1126/science.1258361



(Semi) conductor nucleation

3D microsystems



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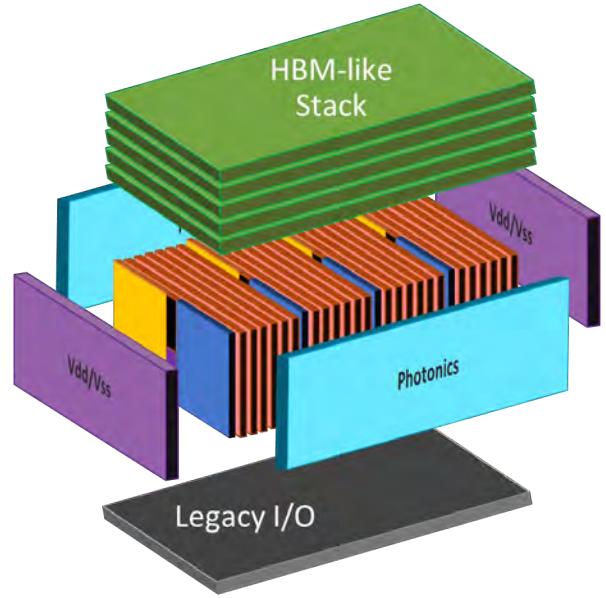

Source: https://www.science.org/doi/10.1126/science.1258361

SWCNT: Single Walled Carbon Nanotube
NP: Nanoparticle
QD: Quantum Dot
HBM: High Bandwidth Memory
I/O: Input/output

Impact: Novel device architectures enabled by bio-inspired 3D fabrication across length scales

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